N ECOLOGICAL APPROACH TO CONSERVATION EDUCATION

**A Supplement to
Conservation Education Programs
of the
Missouri Department of Conservation**

The Missouri Department of Conservation

The Conservation Commission is by law the head of the Department of Conservation, which is responsible for the control, management, restoration and conservation of all wildlife and forest resources of Missouri. The Commission appoints the Director, sets Department policy and approves budgets, regulations and real estate transactions.

The Department was created by an amendment to the Missouri State Constitution. The four Commissioners are appointed by the Governor of the state for staggered terms of six years and must be confirmed by the State Senate. No more than two may be from the same political party. The Department is free of partisan politics and is widely considered a model conservation agency. The Department is financed primarily from the sale of hunting and fishing permits and a 1/8 of 1 percent sales tax voted by the citizens of Missouri in 1976 to implement expanded conservation programs in the years ahead. The Department also receives federal aid funds from several agencies. Collectively, all funding sources support the broad-based programs of the Department, a state agency dedicated to public service and conservation.

As one of the 14 departments of the state government, the Conservation Department undergoes the same budgetary appropriation process and accounting and purchasing procedures as do other state agencies. Also, the Department is audited by the State Auditor as requested by the Conservation Commission.

The Department has divisions responsible for Fisheries, Forestry, Wildlife and Protection programs. Other organizational units are responsible for Conservation Education, Engineering, Fiscal, Public Affairs, Natural History, Operations, Outdoor Skills Education, Personnel and Planning functions.

Instructor Reference Manual

AN ECOLOGICAL APPROACH TO CONSERVATION EDUCATION

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A Supplement to
Conservation Education Programs
of the
Missouri Department of Conservation
Education Section

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Conservation education encompasses all the activities and experiences which result in learning about people's dependency upon and use of natural resources to satisfy their needs and wants. Since 1941, the Missouri Department of Conservation has supported a *formal education* program through Missouri's public and non-public schools.

This publication was developed as a reference source to supplement the Department's expanded conservation education programs. It provides the background information and philosophical base necessary to integrate conservation concepts into the curriculum at all grade levels.

The production of this manual was a challenge which involved many individuals. We are indebted to Director Jerry J. Presley and Assistant Director David D. Hurlbut for their support and encouragement. We are also indebted to Donald K. Heard, education administrator, and Al Palladino, assistant education administrator, for their guidance and assistance. This publication would not be possible were it not for the contributions of Neil Jenkins, conservation education consultant. Also, thanks to Cathy Schwaller, curriculum specialist, for her production efforts.

The *Instructor Reference Manual* is dedicated to the Department's Conservation Education Consultants, past and present. This small group of men and women have recognized education as a vital and important force in resource conservation . . . and have accepted the challenge. The conservation challenge should concern all of us, but especially those charged with shaping today's youth. We hope this series will aid Missouri teachers in meeting this challenge.

For additional information on conservation or outdoor skills education programs, write the Education Section, Missouri Department of Conservation, P.O. Box 180, Jefferson City, MO 65102.

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The *Ecological Approach to Conservation Education* reference manual is designed to help teachers integrate conservation education into their curriculum. The manual provides background information and suggestions for teaching about conservation. It also presents some basic ecological understandings upon which conservation practices should be based. The lesson plans are designed for use with junior and senior high school students. Elements of the narrative and lesson plans, however, may be adapted to *all grade levels* by teachers interested in accurate instruction on conservation principles and practices.

We hope this reference manual will give you the confidence and information you need to teach conservation concepts to your students, the leaders of tomorrow.

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Introduction

Conservation is of most importance to youth.

This manual has been prepared especially for teachers and leaders of youth groups, but should be of interest to anyone who is concerned for the youth of Missouri, our nation, and our world. For *conservation is of most importance to youth.* Although there are immediate benefits to be derived from the practices of conservation, most benefits become increasingly apparent as they accrue and compound with the passage of time. Hence today's youth—and their children and children's children—will derive the greatest benefits from conservation. But the beginnings must be NOW!

Purpose of the Reference Manual

This manual has four purposes: (1) to explain the meaning and scope of conservation; (2) to present evidence of the need for conservation; (3) to present some basic ecological understandings upon which conservation practices must be based; (4) to suggest some ideas for teaching about conservation.

We sincerely hope that this publication will prove useful to you and, through you, to the youth of Missouri—today's and tomorrow's.

The Meaning of Conservation

Although the term "conservation" is relatively recent in origin, references to conservation ideas and practices are not; some appear in the Old Testament!

From the earliest colonial days in America many thoughtful men decried the abuse of the land and its resources. Hindsight now permits us to recognize the contributions of such men as Eliot, Ruffin, Hilgard, Bartram, Parkman, Emerson, Thoreau, Audubon, Marsh, Powell, and Muir—among many—as forethoughts of modern conservation philosophy. But it was not until early in the twentieth century that the concept of conservation was stated as a working definition. Gifford Pinchot, chief forester of the U.S. Forest Service, conceived the idea that there was one, "Central problem of the use of the earth for the good of man." From this idea evolved a policy and a concept which was stated:

> *"The use of the natural resources, for the greatest good of the greatest number for the longest time."*

This definition has frequently been shortened to one which has become the classic for school textbooks:

> *Conservation is the WISE USE of natural resources.*

But no descriptive phrase or definition which contains such subjective words as "good" or "wise" can be entirely satisfactory, so many persons have tried to improve upon and clarify the definition of "conservation." Most such efforts have been no more satisfactory than the original, except—perhaps—to the one proposing the "new" definition. One which has gained considerable acceptance among educators, however, was proposed by Dr. Matthew J. Brennan, former director of the Pinchot Institute for Conservation Studies. He offers:

"Conservation consists in the recognition by man of his interdependence with his environment and with life everywhere, and the development of a culture which maintains that relationship through policies and practices necessary to secure the future of an environment fit for life and fit for living."

Critics of Dr. Brennan's definition are of course quick to point out that his phrases "fit for life" and "fit for living" are as subjective and ambiguous as are the terms "good" and "wise."

A definition of conservation which has been widely accepted—perhaps because of its pure beauty of thought—is that by Aldo Leopold who wrote:

Conservation is a state of harmony between men and land.

Despite the noble and altruistic goals and objectives of conservation as implied by the foregoing definitions, the terms "conservation" and "conservation education" have fallen from favor among many educators within recent years—probably because the actual accomplishments have fallen so far short of the goals.

"Environment" and "environmental education" have become the "in" terms. Many definitions of *these* terms have appeared: most are quite verbose. A careful analysis of these definitions reveal that there are really few, if any, conceptual differences between these terms and the former. Many individuals and groups have therefore compromised by using the combined phrases "environmental conservation" and "environmental conservation education."

Regardless of the term or definition used, it is of vital importance to realize that (environmental) conservation is actually a pattern of human behavior with respect to man's environment.

Conservation is actually a philosophy of daily living.

Levels of Conservation Effort

There are three levels of conservation effort: preservation, restoration, and management.

Preservation

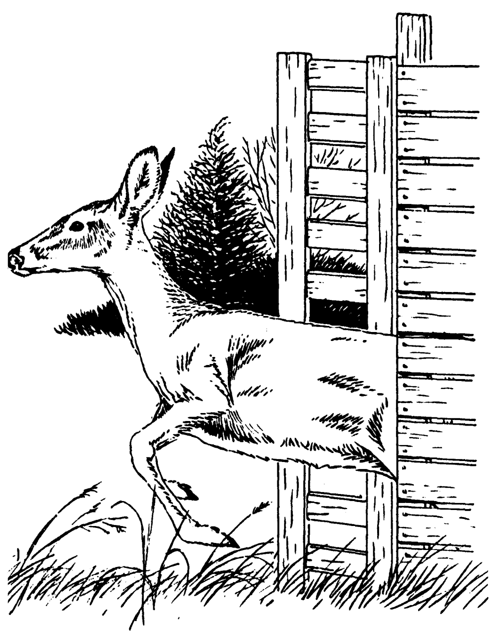
Preservation means saving. It implies little or no use of a resource. There are certain resources—true wilderness, endangered species of plants or animals, small tracts of unique fragile ecosystems, historically important buildings—in which preservation is the only possible method of conservation.

A good example is afforded by the prairie chicken in Missouri. Many years ago this was an important game bird in the northern and western prairies of the state. But now more than 99% of the original prairie is gone, lost to cultivation or "improved" pastures. There is little suitable habitat left for the prairie chicken, and its population has been reduced to a few thousand birds. Under present conditions preservation is the only reasonable conservation effort.

Restoration

Restoration is the second level of conservation, and is frequently overlooked by most persons. It implies not only the return of once worn-out farmland to productivity, the restocking of a wildlife species to an area from which it had been depleted, the replanting of denuded forest land, the grading and seeding of barren strip-mined areas, or the reflooding of a once-drained waterfowl marsh; but it also implies a long-term effort to reestablish the *original quality* which once existed in the unit being restored. Although some worn-out farmland can be made productive in a relatively short time, restoration should not be considered complete until original fertility levels have been reestablished. (Ideally, of course, original soil depths should also be restored, but such is beyond the capability of mere man!)

Restocking of a wildlife species should not be considered a success until original population levels are achieved or exceeded. Reforestation efforts should eventually achieve a level of fully mature forests of a quality found only in virgin tracts. Pollution abatement programs should not be considered effective until air and water resources attain the quality which existed before the major interventions of man.



This view of restorative conservation is often beyond possible achievement. Once filled with sediment and thus rendered useless as a lake, an impounded valley can never be restored with a free-flowing stream as it once was before a dam was built (would-be dam builders should consider this *before* they decide to build a dam). Once extinct, a species of plant or animal is forever beyond restoration. Once demolished, an architectural masterpiece can never be restored.

A fine example of a successful restoration effort can be found in the case of the white-tailed deer in Missouri. In 1937, the year that the Conservation Commission was officially created, there were fewer than four thousand deer in the entire state. This small population was limited to a few Ozark counties and was too small to support hunting.

Then a comprehensive restoration program was begun. It included changes in hunting regulations, better enforcement, research, live-trapping and distribution, and an educational and informational effort. Today deer are found throughout Missouri. The population is probably larger than it was before white men came into the region, and the herd supports an annual hunting harvest which is many times larger than was the total deer population before the restoration program.

Management

Management is the third level of conservation—*management within the conceptual framework of the definitions stated earlier.* It is on the management level that man finally makes the decisions and implements the practices which determine whether we actually achieve the goals inherent in our definitions.

A cropland field which produces a high quality harvest of

grain, hay, or truck year-after-year without loss of soil fertility or without soil erosion; rangeland which sustains continual livestock grazing without loss of forage diversity and quality, and without soil compaction or erosion; fields and woods which support a continuously high density of diverse wildlife populations; and an urban factory which discharges no pollutants into the air or water are all examples of good resource management at a conservation level.

There are many concrete examples of conservation-level management, but unfortunately there are even more examples of its lack! And lack of such a level of management is what "environmental problems" are all about; achievement of such a level is the ultimate goal of conservation.

The Scope of Environmental Conservation

Man, like most other animals, responds only to a problem situation (often only to a *crisis* situation). Thus the scope of conservation has developed and expanded only as man has recognized problems in his environment. *Only* when fields failed to produce crops because of soil depletion or erosion did man become concerned about soil conservation. *Only* when water tables dropped below practical use levels, floods became more numerous and damaging, or surface water became so polluted as to become unusable did man become concerned about water conservation. *Only* when timber supply became short or increasingly difficult and expensive to obtain did man become concerned about forest conservation.

Only when wildlife populations declined substantially or, in extreme cases, became extinct did man become concerned about wildlife conservation. *Only* when many persons became ill or died because of air-borne poisons did man become concerned about air conservation. *Only* when shortages of fossil fuel supplies and certain minerals became acute did man become concerned about energy and mineral conservation.

Only when man's numbers increased so rapidly as to make quite real the specter of famine, caused global unrest, and eroded personal freedoms did man become concerned about population controls. *Only* when man saw many of his own creations buried, flooded, razed, or otherwise destroyed did he expand his concept of conservation to include man-made structures.

Today the scope of conservation encompasses all of these problem areas and concerns, and there are those who would include political systems, economic systems, racial bigotry, and other social institutions within the sphere of "environmental concerns." Although there can be little question that these latter do influence, and are influenced by, conservation efforts, most would probably agree that to try to include *all* of the world's social, political, economic, racial, and religious problems within the scope of environmental conservation would create an apparition of such

magnitude as to appear unmanageable. Thus, for reasons of practical attack, the scope of environmental conservation is usually considered to include only "natural" and man-made physical resources.

The Need For Conservation

The ultimate reason for conservation is the survival of man! There are currently some resource use practices which endanger health and, if not curtailed, threaten man's survival as a species. Few conservationists believe that this catastrophe *will* occur, although most agree that it *could*.

A more immediate reason for conservation is the evident decline in the overall "quality of life" and "standard of living." We can identify several reasons for implementing conservation that are directly related to living standards and quality of living:

1) There is an *economic* reason for conservation. All of us depend upon natural resources for the necessities—and the luxuries—of life. We use our soil, water, forests, wildlife, and minerals to provide our food, our clothing, our shelter; we use them to provide all the gadgets by which we seem to measure our "standard of living." Our economy is based upon the utilization of our natural resources, thus it is essential that the resources be safeguarded so that they can continue to supply those things we need and want.

Conservation is everybody's business. If we do not use the natural resources wisely—if we continue to squander them recklessly—we will surely lose our high standard of living and our economy will collapse. Poor land makes poor people (and poor people, in turn, make poor land)!

2) There is a *political* reason for conservation. The natural resources of planet Earth are not equally distributed. Most people live in areas where they have long suffered from a paucity of natural resources. Only a small part of the world's population has been blessed with relative abundance of natural resources.

Perhaps the inhabitants of the United States have been most fortunate of all. Because of great natural wealth a society of relative freedom evolved. An individual could make the decision as to how to use a resource. One could make a mistake in resource use without one's error having undue impact upon the whole society. There was seemingly always more of whatever it was that had been wasted.

But poor societies cannot afford the luxury of waste. An individual cannot be permitted freedom of choice with respect to resource use; a mistake in use might be too costly to the society as a whole. Therefore, freedom and liberty cannot really exist in such a land. Only in a land that is rich in natural resources can freedom of choice exist, and this freedom can survive only so long as the resources remain abundant. If the resource base weakens, then freedom of choice will be curtailed by the society.

There are other values to be derived from conservation—values which cannot be measured by the dollars of economics or the realities of political repression.

3) There is an *aesthetic* reason for conservation. Almost everyone longs, at least occasionally, to get away from the "artificial" surroundings of a man-made environment—to get outdoors and commune with nature. Some people enjoy watching and listening to birds; others seek streams and lakes; still others derive their relaxation and peace of mind by hiking in the woods, observing wildflowers, floating a meandering stream, pitting their skill against a wary fish, or stalking wild game with gun or camera. Urbanites may picnic in a nearby park, walk in a vacant city lot, or search for any bit of "open space" which offers a change of pace from the daily routine. Some persons enjoy the rigors of winter in the outdoors; others prefer the colorful glory of autumn; nearly all are stirred by a sense of release and renewal during nature's resurgence in spring.

Through our ties with the earth and its varied life forms we are urged to preserve our natural heritage for our pure enjoyment and for our mental health. (There is scientific evidence to suggest that since man evolved in a "natural" setting, he actually *needs* frequent and close association with nature in order to function properly.)

4) There is a *scientific* reason for conservation—especially the conservation of natural areas and wilderness by preservation. How can man evaluate his use of the land and its resources unless he has some standard (scientific control) with which to compare? And, although man seems most unwilling to accept this fact, *Nature—unaltered by man—is the only acceptable standard to which man can compare his alterations of his surroundings.* It is the only way to see where man has been, and perhaps help him recognize where he is going. It is imperative that man maintain an adequate amount of unchanged natural land for this purpose.

5) There is also a *moral* reason for conservation. Man is the dominant reasoning species upon Earth. He has assumed possession and control of nearly all of Earth's resources.

Although man does not have the ultimate decision as to whether *he* will survive upon Earth, he does have considerable power to decide which other life forms, both plant and animal, will survive. Man did not create these other life forms; he has no right to destroy them completely. Neither does man have the right to destroy the surroundings upon which they—as well as he—depend. Man has the moral obligation to safeguard and perpetuate all those things over which he has assumed control; with such custodianship goes corresponding responsibility.

Basic Ecological Understandings

From the foregoing discussion it is evident that if man is to practice conservation he must first have a good understanding of the workings of nature. There are several possible approaches to the study of nature, but the best for developing understandings upon which to base conservation principles is the ecological approach.

Ecology is a basic division of the science of biology; it is concerned with the study of the interrelationships which exist among organisms and their environment. These interrelationships can be

almost incomprehensibly complex for even the simplest organisms. The interrelationships which exist for a complex organism such as man and his environment become infinitely more so. A study of *human ecology* must also include consideration of concepts and understandings associated with other disciplines of knowledge (geographical understandings, for example, are especially important).

It is vital for every citizen to acquire some basic ecological understanding.

Although ecological relationships can be very complex, basic concepts and understandings have been identified and stated. Many fine texts have been written by highly competent ecologists, but most have not been written for the "average" layperson. Basic ecological understandings have not been an integral part of *general* educational curricula. Recently some ecologists have realized that it is vital for *every* citizen to acquire some basic ecological understandings if conservation is to become reality, and they have expressed the most important concepts and understandings in language which is more readily understood by nearly anyone.

Dr. Eugene P. Odum, one of the world's most renowned ecologists, suggests a manner of delimiting ecology according to a concept of biological organization. Biology can be thought of as being organized in a "spectrum" which proceeds thus: (1) protoplasm, (2) cells, (3) tissues, (4) organs, (5) organs systems, (6) organisms, (7) populations, (8) communities, (9) ecosystems, and (10) the biosphere. Ecology can then be thought of as that division of biology primarily concerned with the latter four levels of the "spectrum"—those levels beyond the individual organism.—This concept provides an excellent means for relating these important terms to one another. A *population* includes groups of individuals of any one kind of organism; a *community* includes all of the populations in a given area; an *ecosystem* comprises the community (living organisms) and its non-living environment; the *biosphere* is that portion of the earth which can and does support life—the soil, air, and water.[1]

Protoplasm

cells

tissues

organs

organ systems

organisms

populations

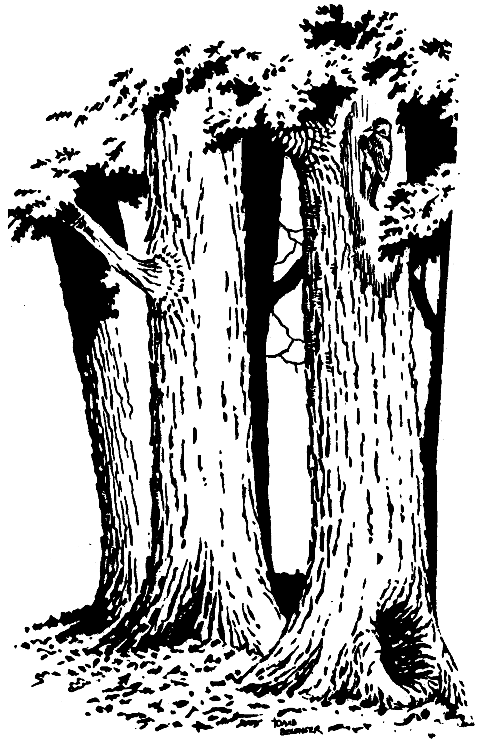
communities

ecosystems

biosphere

The kinds of organisms, and their numbers, which exist within an ecosystem is determined by (1) conditions within the non-living portion of the ecosystem, and (2) the interactions among the community members within the ecosystem. The non-living factors, or physical environment, which influence the organisms include such things as temperature, light, nutrients, water, and fire. Every kind of organism can exist only within an established range of tolerance to such factors or conditions. Too high (or too low) a temperature—either daily or seasonal, too much (or too little) light, an insufficient or unavailable supply (or an excessive amount) of a given nutrient or chemical, too much (or too little) water, or the presence (or absence) of seasonal fire may exclude a kind of organism from, or restrict its numbers within, a given environment.

[1] Odum, Eugene P. *Ecology,* New York: Holt, Rinehart & Winston, Inc., 1963. p. 3.



Since the relative abundance or scarcity of any one factor or condition can effectively limit the kinds and numbers of organisms in a given area, such factors or conditions are known as *limiting factors*. Factors other than those listed can also be limiting factors. The success of any population depends upon such a complex set of conditions that *any* condition which approaches or exceeds the limits of tolerance (either minimum or maximum) for that kind of organism becomes, in fact, a limiting factor.

There exists within every ecosystem a community of living organisms, both plant and animal, which are best suited to living there. These are not necessarily the only organisms which *could* survive in this environment, but these are the organisms which *have excelled* all competing organisms in the struggle for survival. The community is comprised of those organisms best adapted to that environment. This is one of nature's most basic laws; the *law of adaptation*. Examples of adaptation are limitless; every organism which survives in an environment is demonstrating adaptability.

Organisms which first successfully adapt to and become established within a given environment are, however, responsible for their own failure to survive! The community itself modifies and changes its own environment. After a time conditions are produced to which other organisms are better adapted than are the original community members; the original organisms are thus pushed out by these better adapted newcomers.

These new organisms in turn produce changes in their environment which result in *their* being succeeded by still other organisms which are even better adapted to the changed conditions. And so it goes. This process is known as *ecological succession,* sometimes referred to as another of nature's laws: the *law of succession.* The rate of ecological succession is influenced by the physical environment (for example, succession will likely proceed more rapidly in tropical regions than in polar regions), and changes in the physical environment may affect the process of succession in any given situation.

Succession results in a series of temporary communities, each lasting only as long as its members can tolerate the constantly changing conditions which they themselves produce. The process continues until, finally, there is a community which is able to survive its own modifications of its environment. This community can propagate itself (for example, little trees of a species can live in the shade of big trees of the same species), and thus it endures and becomes a relatively stable, although very dynamic community known as a *climax community.*

[There is some question among ecologists as to whether a climax community can continue to propagate itself *indefinitely.* Some evidence indicates that such a community may undergo an "aging" process which ultimately results in the death of the climax community and its replacement by a young—even quite different—community. This question may never be satisfactorily answered because natural or man-made catastrophes (violent wind-

storm; calamitous fire; "reclamation" project; exploration for minerals; major impoundments) will quite likely shorten the life of most climax communities before adequate research can be conducted.]

The series of communities which result in a climax community is called a *sere;* each stage (temporary community) is known as a *seral stage.* Progression through a sere is an orderly process, and the community changes are generally directional and predictable. Seres which require a long time for completion, however, are more likely to be interrupted by severe storms, serious fires, or climatic changes than are seres which require a relatively shorter time; longer seres are therefore less predictable than are shorter seres. For example, a sere which begins with an abandoned cropland field and reaches a climax grassland stage within (perhaps) 40 to 50 years is less likely to be interrupted than is a sere which begins with an abandoned field but requires 200 years or more to reach a climax forest stage. The more time that elapses, the more likelihood of seral interference.

During the process of ecological succession other trends toward change occur which are of significance in man's use of land resources: 1) There tends to be an *increase in diversity* of species as succession advances from one seral stage to another, 2) During early seral stages *gross* community production seems to increase toward a maximum level, then show little change in later stages, 3) *Net* community production seems to decrease during later seral stages, while community respiration appears to increase, 4) The total biomass (organic matter) within the ecosystem continues to increase during the entire sere.

All organisms require a source of energy

Regardless of the composition of an ecological community or of its physical environment, *all organisms require a source of energy, and all organisms require certain raw materials of which the organism is composed.*

The source of energy for nearly all living organisms is the sun. Green plants, using raw materials from the air, water, and soil, with aid of chlorophyll convert a portion of the sun's energy which falls upon their leaves into food energy through the process of photosynthesis. That portion of energy which is not utilized by the plants for their own metabolism is stored within plant tissues. This stored energy then becomes the source of food energy for all *herbivores* (plant-eating animals).

The herbivores utilize a large portion of the energy acquired from the plants for their metabolic functions; the unused energy is stored within their animal tissues. *Carnivores* (meat-eating animals) then obtain their needed energy from that stored within the tissues of the herbivores or from *omnivores* (animals, including man, which eat both plant and animal tissue to obtain food energy). Some carnivores may also obtain a portion of their food energy from eating other, usually smaller, carnivores.

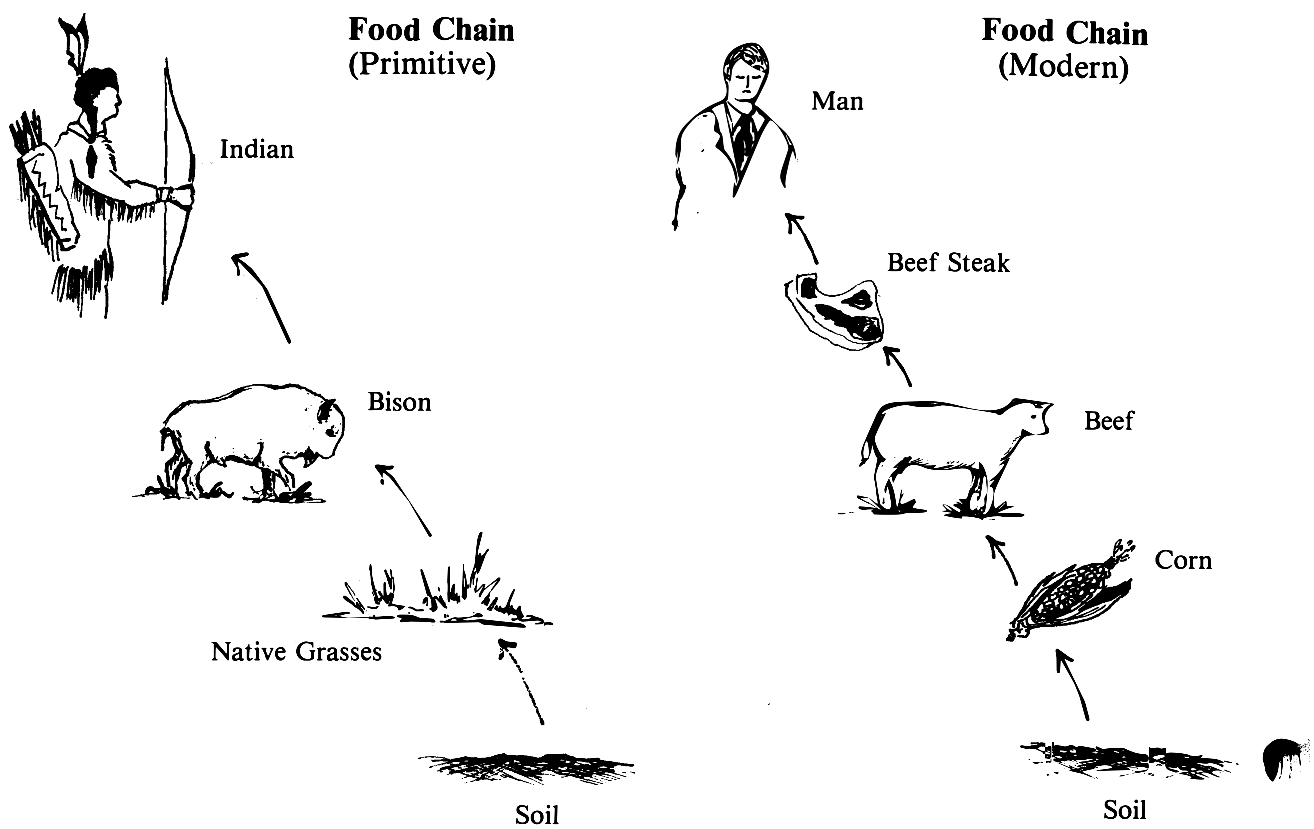
Most food energy is converted to heat.

As food energy is transferred from plants to herbivores, and from herbivores to carnivores (or omnivores functioning as carnivores), there is a great degradation of energy into heat; only a

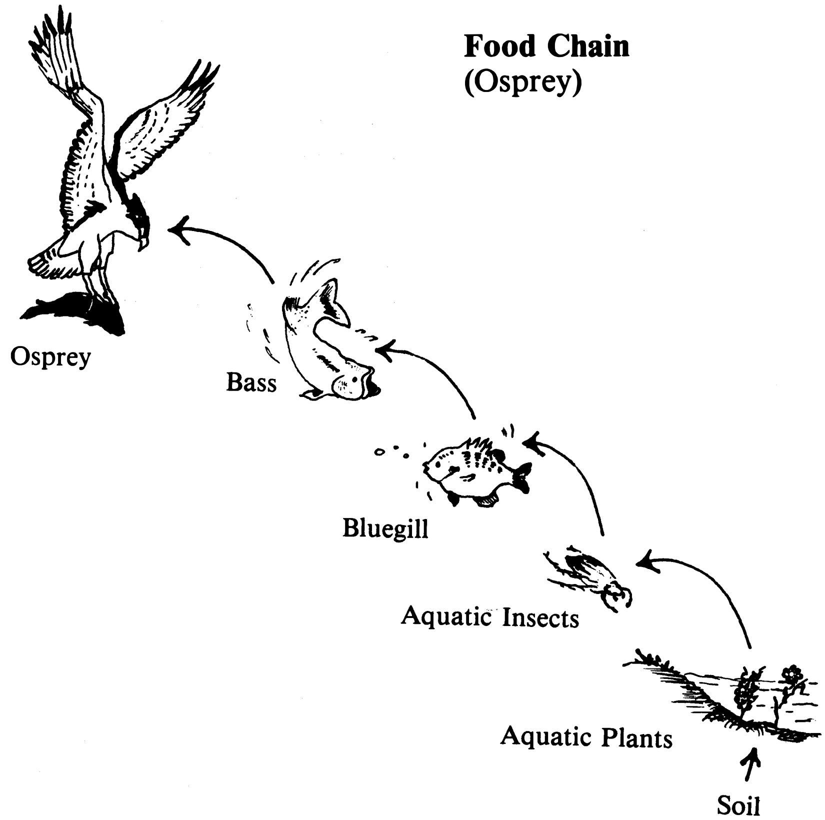
small portion of the stored food energy is actually passed on and available to the next level of energy users. For example, if 2000 Calories (a Calorie is a unit of measurement of energy) of light energy were absorbed in one day by the plants covering a square meter of land, perhaps only 20 Calories would be stored within the plant tissues and be available as food energy to herbivores; probably only about 2 Calories would be stored as energy within the tissues of the herbivores; and likely only .2 Calorie would become a part of the energy stored within the tissues of the carnivores. It is thus quite evident that it requires much plant-stored energy to sustain only a few herbivores—and even fewer carnivores.

This series of transfers of food energy from one organism to another is called a *food chain* or *energy chain.* Every food chain follows the same general pattern: green plants → herbivore → carnivore. Depending upon the organisms involved, a food chain may include one, two, or even three links of carnivores. *Scavengers* (animals which feed upon carrion) function as carnivores in food chains.

Because terrestrial herbivores are often fairly large animals, terrestrial food chains tend to be quite short and simple—frequently only three links. Aquatic herbivores are usually small, thus aquatic food chains are likely to include the additional carnivorous links. All food chains, however, are limited to but a few links because of the great degradation in energy as it is transferred from one organism to another.



Food Chain
(Osprey)



This process of energy flow can be illustrated by a diagram which is known as the "biotic pyramid" or, frequently, as the "pyramid of life." (page 12) Its base represents the sun's energy, together with other raw materials of life: soil, water, and air. Upon this base rests a segment which represents the green plants—the organisms which convert the sun's energy into a form usable by other organisms. Note that this segment is smaller than the base to illustrate the fact that only a small portion of the sun's energy is utilized by the green plants. (If the diagram were in proportion, the base would be 100 times larger than the green plants segment!)

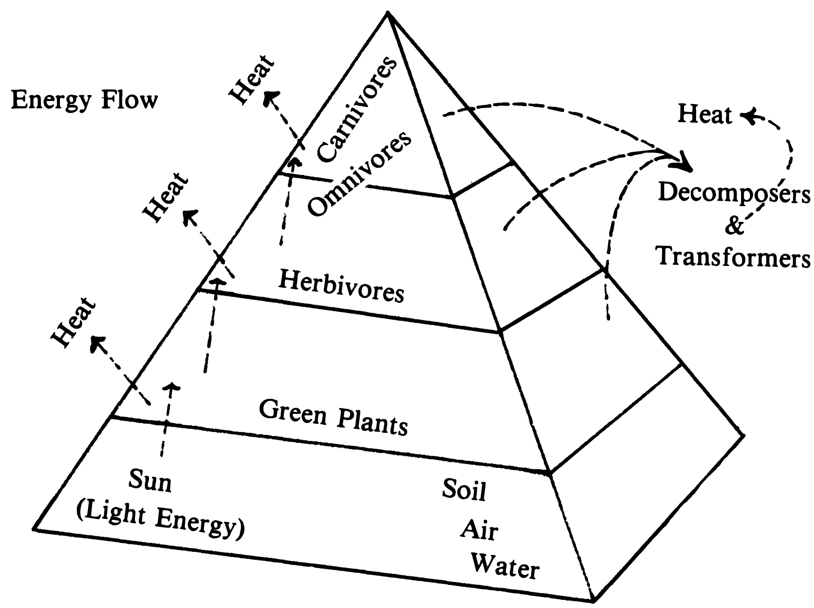
The next segment of the pyramid illustrates the herbivores—the organisms which utilize the sun's energy by eating green plants. This segment is likewise smaller than the one upon which it rests to emphasize that herbivores obtain only a small portion of the energy converted by the plants. The top segment of the pyramid represents carnivores—the "top" level in the flow of energy.

Although there *may* be more than one carnivorous link in a food chain, there is only one level of function in the energy flow. The segment representing carnivores is also smaller than its support to indicate that it takes a much greater mass of herbivores to support a given mass of carnivores.

Omnivores are not represented by a separate segment in the diagram, but are merely noted as being a part of the animal realm. Their location upon the pyramid depends upon the function they perform at any given time; sometimes an omnivore functions as a herbivore, sometimes as a carnivore.

From the discussion of energy flow and the illustrations of food chains and "pyramid of life" another very basic ecological principle becomes evident; *energy flows only one way*. Energy, once used by an organism for metabolic functions, is dissipated as heat into the physical environment and is lost to the ecosystem. It cannot be used again to provide energy for any organism. Therefore, nearly all organisms depend upon a continuous flow of energy from the sun. (Some few types of bacteria obtain their energy from inorganic substances by chemical processes.)

Pyramid of Life



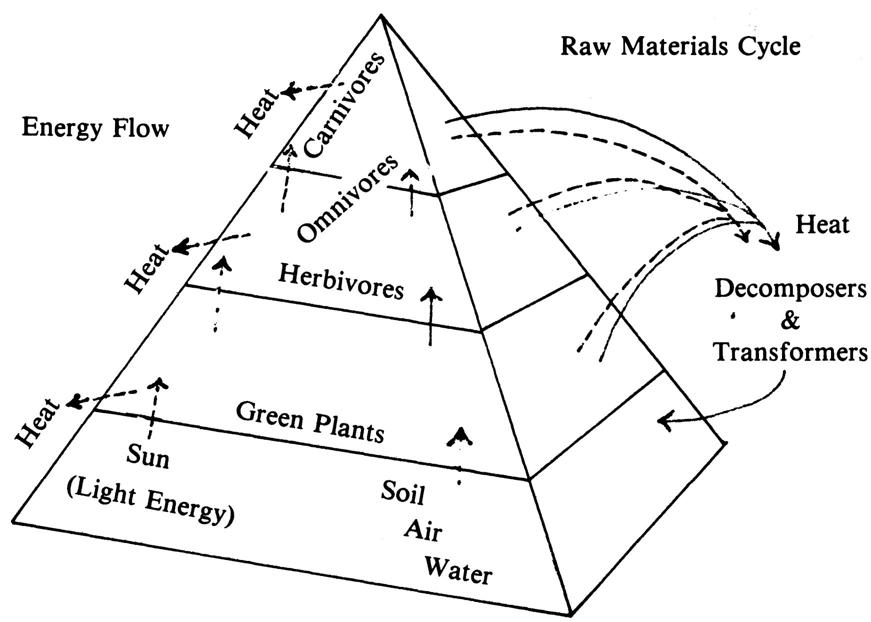
Equally vital to all organisms are those non-energy raw materials of which all protoplasm (living material) is composed. Elements and compounds such as carbon, hydrogen, oxygen, nitrogen, potassium, calcium, magnesium, sulfur, and phosphorous are required as the major components of organisms; others such as iron, copper, zinc, manganese, and sodium (this list is *not* complete) are essential to certain organisms, but in lesser quantities.

Non-energy raw materials are also transferred from one organism to another directly in the food chain. Unlike energy, however, there is no loss involved in the transfer. The elements within each organism are transferred to that organism which eats the first. Even more important, these materials are usually not lost

to the ecosystem when the final user in the food chain dies. These raw materials are released back into the ecosystem by the action of *decomposers* and *transformers* (usually microorganisms) which obtain their energy from that which remained stored within the tissues of the dead organism.

As these decomposers and transformers extract the final bits of energy from the food chain, the residue comprises the original non-energy materials. Such materials are then once again available to be assimilated and utilized to compose the protoplasm of other organisms. Hence, although energy flow is a one-way process, the non-energy materials are used again and again. This fact is another of the major principles of ecology: *basic non-energy materials are circulated among organisms and between the organic and non-organic components of the ecosystem.*

Pyramid of Life

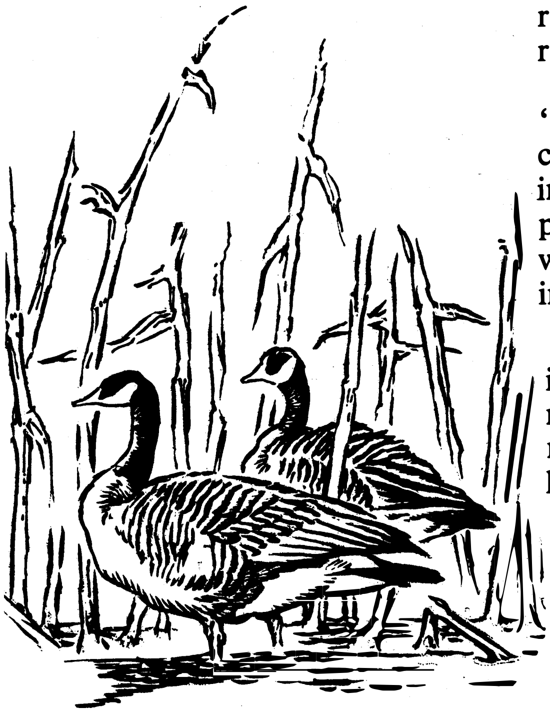


These circulatory movements of elements between the living and non-living components of the biosphere are known as *biogeochemical cycles;* "bio" refers to the living organisms, "geo" to the non-living portion of the environment. Some of the general processes and sequences involved are known for some of these cycles (the nitrogen cycle," the "carbon cycle," the "sulfur cycle," the "oxygen cycle," etc.), but the details are as yet poorly understood.

It is known that microorganisms play the key role in most biogeochemical cycles, but microbial ecology is in its infancy. For

this dicussion it is sufficient to understand that the circulation of these raw materials is a vital process for all living things. (Any reader desiring further information about biogeochemical cycles is referred to any standard ecology text.)

The function of biogeochemical cycles can be illustrated on the "pyramid of life" diagram by adding "circles" to represent these collective cycles. It must be emphasized that some of the elements involved circulate primarily through the air portion of the pyramid's base, others through the soil, still others through the water. Frequently all portions of the base (other than the sun) are involved in each cycle.



Every species of living organism has the capability to reproduce itself; most have a potential to produce progeny many times the numbers of parent stock. This power of reproduction is another of nature's laws: the *law of multiplication.* Examples of this law are limitless:

A single kernel of corn germinates and grows into a corn plant; the plant produces one or more ears; each ear produces hundreds of kernels!

How many acorns on a large oak tree? Each acorn is potentially another oak tree! (How many years will the oak tree produce acorns?)

A single cottontail rabbit (female) may bear 18 or more young in a single season!

A female fish may lay hundreds—even thousands—of eggs; each egg has potential of becoming another fish!

How many tomatoes grow on a single tomato plant? How many seeds are there in each tomato?

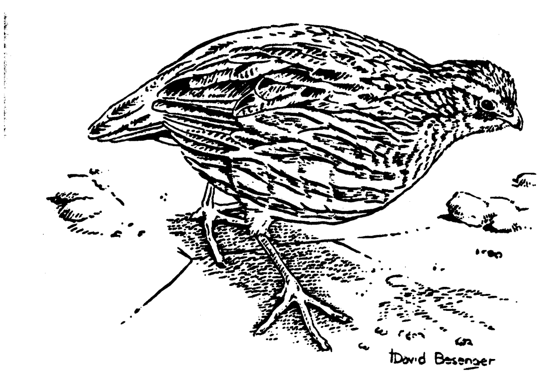
How many kittens does the mother cat bear in each litter? How many litters?

Do you know any family that has more than two children?

So great is the reproductive potential of *any* species that it could, if its powers of multiplication were unchecked, overrun the Earth!

But fortunately no one species does overrun the Earth. Nature has provided a check to the effects of unlimited multiplication: the *law of control.* Predation, consumption, disease, fire, floods, parasitism, starvation, and many other means prevent the unlimited growth in numbers of any species. By the law of control the Earth is saved from the potential catastrophe of unchecked multiplication.

Thus, using energy from the sun and raw materials from their physical non-living environment, organisms which have survived the limiting factors and adapted to their surroundings interact in many ways, perhaps modifying their environment so that succession occurs, always multiplying profusely, but being kept in check by various controls. Eventually some sort of dynamic equilibrium or balance is established which produces within the ecosystem (small or large) the greatest amount of life that it can support. This maximum productivity is called the *carrying capacity* of the area under consideration.



The concept of carrying capacity is one of the most important in ecology—and for conservation. Carrying capacity may be interpreted in several ways: (1) It may be thought of as the *total number of organisms* which can be produced and sustained by an ecosystem; (2) It may be thought of as the total number of *organisms of a given functional type* (i.e., plants; herbivores; carnivores) which can be sustained by an ecosystem; (3) It may be thought of as the total number of *organisms of a given species* which can be sustained by an ecosystem. Of the three interpretations, the second and third are of most importance for conservation.

For example, a given lake may have sufficient green plants (primarily phytoplankton) and herbivorous organisms to sustain a population of 500 three-pound carnivorous fish; or the same lake could sustain 750 two-pound carnivorous fish; or 1500 one-pounders. The carrying capacity of this lake would be 1500 pounds of carnivorous fish—regardless of their size. The carnivorous population could consist of a relatively few large fish, many small fish, or some combination of various sizes which totaled 1500 pounds.

Similarly, a 100-acre pasture of mixed grasses and legumes might sustain a grazing herd of 15 horses for the season; *or* 20 cattle; *or* 100 sheep. Or the same pasture might sustain a mixed herd of livestock—perhaps seven horses and ten cattle, or three horses and 16 cattle. The proper number of each kind of animal would depend upon their size (hence their forage requirements), but the total number of animals which could be sustained would be determined by the productivity of forage in the pasture. This productivity determines the carrying capacity for each kind of animal.

A 240-acre farm might sustain a quail population density of one bird for each three acres; this density would be the carrying capacity of the farm for this species of organism. But the carrying capacity can be changed. If the farmer removes some fencerows which grow many annual "weeds" ("weed" seeds are a staple food for quail), the carrying capacity of the farm for quail might decrease to one bird for every six or seven acres. But if, instead, the farmer plants several annual food plots on the farm, the carrying capacity of the farm for quail might increase to one bird for each two acres.

Man's Ecological Relationships

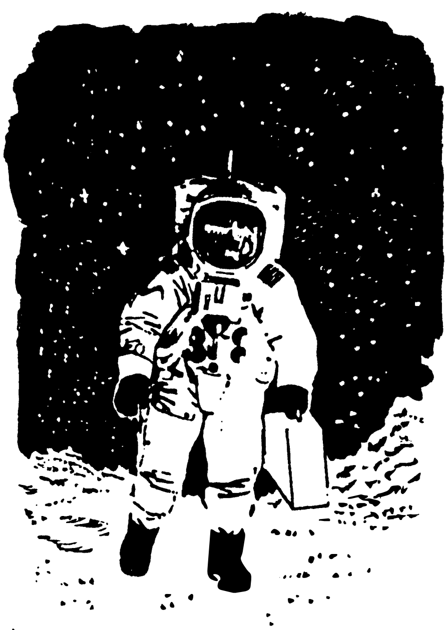
In the foregoing discussion of basic ecological understandings, no special consideration was given to man or to his role in ecological interrelationships. This "omission" was deliberate. The ecological principles discussed are applicable to *all* organisms—including man. Although man has become the dominant species of the Earth community, *man is not the master of nature. Man is a part of nature and is subject to all of its laws!* Man is but another of the myriad organisms which compose the community of Earth's ecosystem.

But man is peculiar among Earth's community members. *Man*

believes that he is not really a part of this community. Man *believes* that he is separate and apart from other community members, and that *somehow* he is not subject to the same ecological laws and principles. And since man always acts upon his beliefs (be they right or wrong), man's relationships to his environment have been very unique and do deserve special consideration.

Man is a part of nature and subject to all of its laws.

As every organism which exists upon Earth today, man has adapted to Earth's environment, but his tolerances to variations in this environment are surprisingly limited. Myriad organisms are more tolerant of variations in environmental conditions than is man, but man *believes* that he is extremely adaptable. Man cites examples of his habitation of both the torrid tropics and the frigid arctic, and of his occupancy of sites from below sea level to high mountain ranges. Man has "proved" his adaptability by living beneath the sea, by surviving journeys through outer space, and by walking upon the surface of the moon!



Actually, however, only a relatively small number of man's population has successfully adapted to the oxygen-rare atmosphere of high mountain habitats. Only a portion of man's numbers has adapted (by skin pigmentation) to the rays of the blazing tropical sun. *No* man is adapted to survive the environment beneath the sea, or of outer space, or of the surface of the moon.

What man has really accomplished, of course, is to use his superb ability for developing and using tools to create small portable environments in which he can survive and function while visiting or inhabiting inhospitable surroundings. Thus his specially selected animal skin (or now man-made fiber) garments enable him to withstand both the heat and harmful rays of the tropical sun and the extreme cold of arctic lands.

His oxygen tank and mask permit him to function at high elevations on the land or in the air. His submarine or diving bell allows him to exist beneath the waters of the sea. He lives in a bit of an Earth-type environment during his excursions into outer space. Thus man, rather than being adapted (physiologically) to a wide range of environmental conditions, alters—on a small scale—his immediate surroundings to fulfill his survival needs.

The environment to which man is *truly adapted* has developed over millions of years; man's adaptation has likewise taken place over eons of time. It thus becomes evident that *any changes in man's physical environment are more likely to be harmful than beneficial to man.* Pollutants which permeate Earth's atmosphere thus increase the incidence of respiratory ailments in man. Contaminants in Earth's waters—streams, oceans, lakes, groundwaters—multiply the likelihood of persons becoming afflicted with water-borne disease as they drink or bathe.

Deadly poisons spread upon the land, either deliberately or by accident, enter man's food chains. Destruction of the forests and grasslands in which man developed—successively as a food gatherer, a hunter, a herder, and as a tiller of the soil—creates a void which places a stress upon man's psychological being.

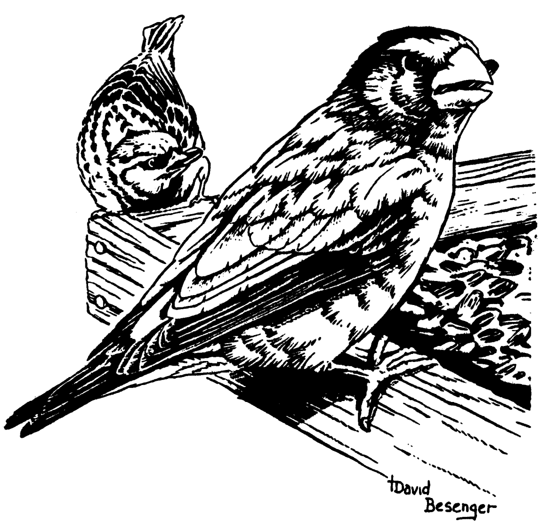
Organismic adaptation is an extremely slow process, but the current alterations in man's environment are taking place with relative rapidity. The effects upon man thus *must* be detrimental to his well-being, perhaps to his survival.

For many centuries man has recognized certain limiting factors in his physical environment. Man has *believed* that he can successfully overcome these factors, and he has enjoyed some success in his efforts; he can apply fertilizers to the land and thus overcome some chemical deficiencies in the soil; he can irrigate certain lands and overcome an environmental lack of water; he can drain swamps and marshes and overcome an environmental factor of too much water; he can produce food plants the year-around in man-made environments (greenhouses) regardless of outside temperature or weather conditions. All of these accomplishments, of course, require tremendous expenditures of energy.

What if a power shortage should reduce man's ability to maintain the artificial temperature in the greenhouse? What if there were no fertilizer available to spread upon the land for a season—or for several? What if the source of irrigation water were to be diminished or completely eliminated? What happens to the water that was previously stored in swamps and marshes?

Are the limiting factors really overcome—or are they but being held in temporary abeyance?

Some of man's efforts to overcome limiting factors have, in fact, created environmental changes which have themselves tended to become limiting factors. Drainage of wetlands has eliminated many aquatic ecosystems and their very high productivity; drainage has also altered local water cycles. Surplus water from some drained areas now creates flooding in other, downstream, areas. Improper irrigation has caused soil toxicity in some fields because of an accumulation of mineral salts. In other areas a man-made desert has been created by the depletion of water reserves by irrigation. In some localities the application of too much fertilizer has resulted in water toxicity.



Obviously not all of man's efforts to overcome and control limiting factors within his environment have been as successful as he is prone to believe.

Man has deliberately introduced many species of organisms (he has also introduced countless others *unintentionally)*, both plant and animal, into environments from which they were previously missing. Some of these introductions may have been the result of man's recognition that organisms have specific environmental needs, but most were probably done on a hopeful "hit or miss" basis. Many of the introduced species have been of great benefit to man.

Many food plants, for example, have been introduced successfully into areas where they were not previously grown; none of today's major agricultural crops of the United States are native species. Although the successful introduction of any exotic species will, of course, result in disruptions of the ecosystems into which

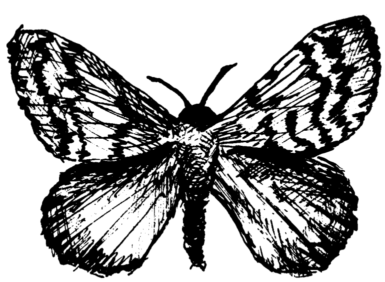
they are introduced, many have seemingly not resulted in adverse (to man) ecological relationships.

Sometimes, however, an introduction of an exotic species has resulted in unexpected and undesirable effects; the new species has adapted *too well* to its new environment. The English house sparrow, the starling, and the German carp are well-known examples of animals—deliberately introduced into the American environment by man—which adapted so successfully that they are now considered nuisances. Man may have remembered the law of multiplication when he introduced these species, but he apparently overlooked the law of control. These exotics did multiply—abundantly! But their usual species control agents were lacking in their new environment, so their population growth was insufficiently checked and they spread rapidly from the areas of introduction.

Johnson grass, musk thistle, and wild hemp are but three examples of plants—deliberately introduced into the United States—which have produced unexpected and undesirable results.

Musk thistle has long been grown as an ornamental in some countries of Western Europe. About fifty years ago it was brought to the United States, probably for the same purpose. Today it has spread to become a "noxious weed" (legal definition) in Nebraska, Kansas, and Iowa—and it is spreading rapidly in Missouri!

Hemp is a native of Asia and has been grown in various parts of the world for centuries. Hemp has been grown in the United States since colonial times, and was formerly grown for its fiber as a cash crop in Missouri. Today, however, wild hemp (the descendants of plants which escaped from cultivated fields) is considered an undesirable, not as an agricultural weed but as a societal menance. Wild hemp is also known as marijuana, the source of a mild hallucinogen whose use (illegal in most states) is thought by many to be harmful to the user and to society.



Accidental introduction of organisms into a new environment by man's activities has often caused even more problems. The mere listing of a few examples will illustrate: the Norway rat; house mouse; European elm bark beetle (which spreads the fungus that causes Dutch elm disease); gypsy moth (whose larvae defoliate entire forests), field bindweed; and the infamous "cheat grass" (*Bromus tectorum)* of the Western rangelands.

For many centuries man has made use of certain characteristics of early seral stages of succession to produce most of his food—perhaps without understanding why. Most food crop plants are of types usually associated with early seral stages (e.g., man's breadstuffs—corn, wheat, oats, rye, barley—as well as rice and sugarcane are all grasses). Early stages of the succession process are more productive than are later stages, so man has benefited from greater food production. A farmer really keeps setting back succession to an early stage as he plants his annual crop.

Foresters have accelerated tree growth by shortening the time periods for certain seral stages. Good timber management today can produce a mature tree ready for harvest in but a fraction of the

time required by natural succession processes. For example, a Missouri walnut tree which might require 80 to 100 years to reach maturity by natural growth rates may achieve the same size in but 50 to 60 years under good forest management practices.

Wildlife managers enhance habitat for desirable (by man's values) species of wildlife by perpetuating those successional stages most productive for the desired community. Keeping an area in a very early seral stage of annual plants will greatly benefit the Bobwhite quail whose diet consists primarily (80%) of seeds from annual plants.

Unfortunately, however, man has tended to neglect the advantages to be derived by utilizing the characteristics of later stages of succession. *Diversity* is a characteristic of late seral stages, and in diversification there is stability. Man's increasing reliance upon monoculture to provide for his food and fiber needs and wants carries equally increasing risks.

Weather conditions (or a plant disease) which might prove disastrous to a farmer who grows *only* corn (or *only* wheat, *only* soybeans, *only* cotton, etc.) might not be nearly so damaging to a farmer who practices crop diversification. Likewise, a pasture—or city lawn—which is composed of but a single grass species may easily succumb to a disease which a pasture—or lawn—composed of many diverse grasses and legumes would survive. Some of the variety of plants would surely be resistant to the disease.

Plant diversity = ecosystem stability

Many towns and cities with streets once lined only with beautiful American elm shade trees have become desolate as this species has succumbed to Dutch elm disease. Towns with a variety of species of shade trees have also lost their American elms, but the other species have survived to provide beauty and shade for their streets.

There are also other benefits to be derived from later seral stages. The continuous nutrient cycles, and their diversified communities provide a genetic storage bank. Mature seral stages also modify effects of weather extremes; for example, during storms they will absorb more precipitation, hence reduce run-off and the likelihood of floods.

Thus it would seem that there are several distinct advantages to man's recognition of his interrelationships with mature ecosystems.

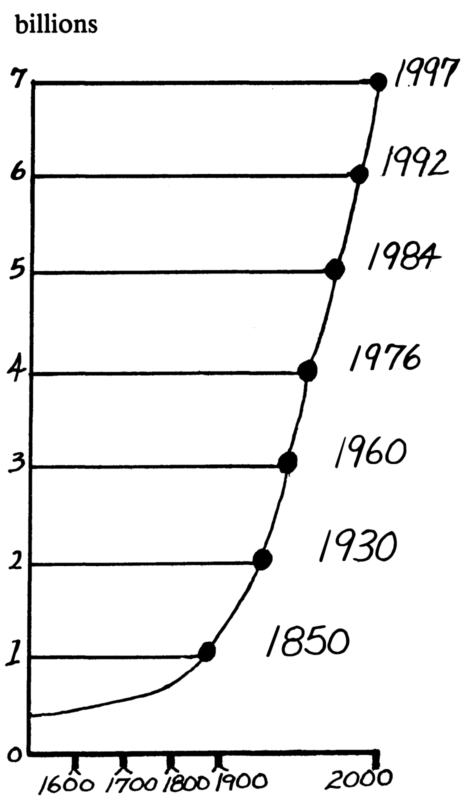
Recognition by man of *his* position within the "pyramid of life" is one of his most important needs, but even more important are man's behaviorial patterns that demonstrate cognizance of this position. Whenever man's activities result in detrimental effects to those elements of the ecosystem which support man and enable him to survive as a biological organism, it is evidence that man does not really comprehend his dependency upon the energy sources and raw materials from levels below his in the "pyramid."

Whenever man pollutes the air, pollutes the water, erodes and depletes the soil, destroys land as a base for green plants to perform their vital functions of producing food energy for all animals, and otherwise damages the foundation and supporting levels of his own

life-support system, man simply does not understand! And such failure to recognize his own dependency upon the total ecosystem makes it impossible for man to establish realistic long-range goals or priorities for the use of the natural resources upon which he depends.

If man truly understands his dependency upon clean air, there can be no question as to whether or not an individual, or corporation, or a unit of government has a "right" to pollute that air; *if man really understands* his need for clean water, there can be no question as to whether or not any water polluting activity is to be permitted; *if man actually understands* that the land (soil) is the base for his food and fiber, there can really be no question as to whether or not good cropland should be retained for agricultural production or diverted to a shopping center parking lot!

Earlier in this booklet a statement was made that man is a part of nature and is subject to all of nature's laws. This is a truism. But until man's activities show cognizance of his position within and dependency upon the "pyramid of life," conservation is not possible, nor can man's survival as a species be assured.



World Population

Nothing is more important in man's understanding of ecological principles than for man to comprehend fully his own relationship to the law of multiplication, the law of control, and the concept of carrying capacity. The net result of the interaction of the laws of multiplication (increase in population) and control (decrease in population) is population growth—either positive or negative. For man this interaction is usually expressed in equation form:

$$\text{Population Growth } (\pm) = \text{Number of Births—Number of Deaths}$$
$$G\ (\pm) = B—D$$

If the number of births exceed the number of deaths, there is a positive growth or increase in population; if the number of deaths exceed the number of births, there is a negative growth or decrease in population.

Like all other organisms man has the *potential* to reproduce his own kind in such numbers so as to overrun the Earth, but unlike other organisms man has the capacity to limit his reproductions deliberately and thus act as his own agent of control. Like all other organisms man is subject to the effect of the law of control—death—ultimately by "old age" if not by a prior agent, but unlike other organisms man has some capacity to avert deaths from disease, injury, or poisoning and thus postpone (but not eliminate) the eventual effect of the law of control.

Therefore, within the limits established by natural laws, man, alone among all organisms, has the *capability* to determine to a maximum degree the rate of increase or decrease in his numbers. Man thus has a considerable degree of choice in determining his ultimate total numbers here upon Earth.

To date he has chosen not to control his population growth to any significant degree; his numbers have increased at an exponential rate since the advent of agriculture. From an estimated 5 million

humans at the "discovery" of agriculture (about 8000 B.C.) man increased his numbers a hundredfold to an estimated 500 million by 1650 A.D. During this span he doubled his numbers an average of once every 1500 years. By 1850 man's population had grown to one billion; he had doubled his numbers in 200 years. By 1930 the human population of Earth reached two billion, and had doubled in but 80 years. In 1976 the world's human population had grown to four billion persons and had doubled in only 46 years! And at that time the estimated "doubling time" had fallen to less than 40 years!

There is a "carrying capacity" for humans upon this planet!

If man's numbers were to continue to increase at that rate, human population would reach eight billion by about 2015, 16 billion by 2055, 32 billion before 2100, etc. Such growth, of course, cannot and will not continue. There is an eventual limit to the number of humans (or any organism) that the earth's ecosystem can sustain. *There is a "carrying capacity" for humans upon this planet!* The vital factor that will finally halt the growth of human numbers might be food—or pollution—or space—or fresh water—or disease—or any of several other factors, or perhaps a combination of several. But *the increase will be halted;* the law of control and the concept of "carrying capacity" will prevail!

Teaching About Conservation

Some suggest that man has failed to practice conservation because of *carelessness, ignorance, and greed:* Man has been *careless* with resources (especially in America) because he has had too much natural wealth; he simply has not recognized any need to husband resources or to use them wisely. Man has demonstrated *ignorance* by failing to recognize evidence of the effects of his tampering with natural ecosystems, and by refusing to accept—or choosing to disregard—the obvious fact that he is a part of nature's system and is subject to all natural laws. Man's *greed,* his insatiable appetite for material wants, has resulted in his wasting, abusing, and squandering the resources of his planet home with little regard for either other organisms or for the future of his own species.

Carelessness; ignorance; greed! *These can be overcome only by effective education!* Man's real problem with his environment is one of education—of teaching *himself* to use his environment and its natural resources wisely. But how?

A starting point may be to educate youngsters to understand natural laws and principles, and to realize and accept man's niche in Earth's ecosystem. But conservation is more than understanding natural laws; conservation is indeed "a philosophy of daily living" which is exemplified by one's behavior toward one's environment. And behaviors are determined by one's beliefs and attitudes. So how do teachers, youth leaders, and concerned parents help a youngster acquire those "desirable" attitudes (and thus behaviors) about his environment? Not an easy question, nor are there any simple or easy answers.

There are, however, at least three distinct efforts indicated: (1) *set a good example* in one's own personal use of resources; (2) *provide experiences* which will enable youngsters to observe both good

and poor examples of resource use, to compare the effects of such uses, and to evaluate which uses seem most appropriate to fulfill the criteria for conservation; (3) provide *accurate, factual information* about resources and their uses and abuses (this is especially important in those situations where actual observation, comparison, and evaluation is not feasible.)

Actions speak louder than words.

There is an old saying, "Actions speak louder than words," which may be axiomatic for teaching conservation attitudes. Every teacher, every youth leader, every parent conveys *by example* that person's *real* attitudes and beliefs about man's environment and his use of natural resources—regardless of what that person may *say* about man's environment, natural resources, or conservation. (Unfortunately, often the person may not even be aware of his or her behavior, and be even less aware of the example he or she is setting.)

Whenever a teacher instructs pupils to "use only one side of the paper," (thus wasting 50% of the paper's usability) the teacher is in effect saying that there is really no need to conserve pulp trees; whenever a youth leader throws open the windows of the meeting room to "cool the place off" while the heating unit is still running, the leader is in effect saying that there really is no shortage of nor need to conserve heating fuel; whenever a parent "throws away" a usable (by someone) item, the parent is in effect saying that there is an inexhaustible supply of the resources from which the item was made—including the energy used to produce the item! Whenever *anyone* wastes, or condones waste, or otherwise misuses resources or their products, that person is *by example* conveying anti-conservation attitudes about man's environment.

Examine your own behaviors with regard to the use of resources and man's environment.

Thus the first, and doubtless the most difficult, task for any teacher, youth leader, parent, or other concerned person (including professional "conservationists") is to examine carefully his or her own behaviors with regard to the use of resources and man's environment, then make whatever adjustments may be necessary so as to set a good example for youngsters to follow.

Today an ever-increasing number of youngsters, especially in urban areas, lack opportunities to walk through a woods, explore a streambank, or see what they can find in an open field. They are thus deprived of many experiences which would give them more insight into ecological relationships which can best be learned by firsthand observation of the working of nature.

Many city children (and not a few adults) have never seen a cow eating grass; fewer still have watched a cow being milked. They cannot relate the milk in their luncheon carton to the cow, the grass, and the soil, water, air, and sunlight. Neither can they relate most of their other food, their clothes, and the countless other items which they use every day to the resources from which these items were produced. Any understandings of such relationships have probably been acquired from reading a book or, at best, from viewing a movie or watching a television program.

This is certainly not to imply that books, movies, and television are not good—or even important tools for learning desirable con-

servation attitudes, but they are a poor substitute for a real firsthand experience! "Wildlife" to an "inner-city" child may mean only pigeons, English sparrows, and Norway rats (or cruel men clubbing baby seals)—unless he or she has an opportunity to observe others of nature's creatures which inhabit the fields, forests, and streams!

Likewise, many rural youngsters (and also many adults) may not understand the *need* of an urban dweller for more "open space" in and around the city; they may be unable to comprehend the "mountains" of trash that must be disposed of daily from a city; they probably have never experienced the "smog" that can develop during *real* rush-hour traffic conditions. (Even more tragic, of course, is the fact that many rural youngsters cannot really relate the milk in a carton to the cow, grass, and the sun's energy, or that many city children do not relate the constant "bad smell" in the air to the factory where their father may work!)

Create opportunities for children to have firsthand experiences with their environment.

Obviously not every child can be given an opportunity for firsthand experience with every man-environment relationship (nor would such be desirable), but every child *can* be provided many, many more opportunities than he or she is now receiving. Most "reasons" stated for not providing children with more opportunities to experience, to observe, to compare, to evaluate, are really "excuses"—often given by those who do not themselves comprehend the importance of such learnings to the future well-being of the child and to mankind.

Thus a second task for any teacher, youth leader, and parent who is really concerned about conservation education is to create opportunities for children to have firsthand experiences with their environment so that they may observe, compare, and evaluate the many ways in which man uses—and abuses—his surroundings and resources.

"Field trips" (any trip outside of the classroom) are probably the best method for providing children with opportunities for a variety of experiences to learn about their environment, its resources, and man's use of them.

Field trips are of two basic types, with much gradation between: 1) One during which the teacher or other trip leader (sometimes a resource person) conducts a "show-and-tell" trip, pointing out and explaining whatever features the trip leader believes to be of most importance and interest to the group; 2) One during which the participants, either individually or in small groups, are primarily responsible for making their own observations and (perhaps) interpretations.

Most authorities favor the second type of field trip because participants are more actively involved and therefore presumably more interested, but there is no "right" or "wrong" kind of field trip if it fulfills its purpose. The very first question a teacher or other leader must ask is "What is the *purpose* of this trip?" The answer will help the teacher decide which type of trip to conduct.

If, for example, the purpose is to *show* young pupils the many

evidences of erosion which are occurring on and around the schoolgrounds, the teacher might well choose to conduct a "show-and-tell" type of trip; but if the purpose is to have pupils *discover* that there are many different kinds of trees growing in the neighborhood, the teacher would probably select an investigative type of trip.

(Incidentally, if a teacher is not as well informed, thus not as confident as he or she might like, the investigative type of field trip may be better. The teacher and pupils can then learn together! On the other hand, a "show-and-tell" trip might be the best way to utilize the expertise of a resource person.)

Many good field trips are combinations of both basic types. For example, a teacher might point out a bird's nest in the crotch of a tall shrub, then a hole which serves a squirrel as the entrance to its nest, and finally the mouse travel-path which runs beneath the matted grass and weeds. Then the teacher might instruct the pupils to search for other wildlife homes and evidences of animal life in the area. (The pupils should of course be cautioned not to disturb any nests, dens, eggs, or young animals which they might find.)

Field Trips: Where to Go

Possibilities for worthwhile field trips to learn about man's environment are practically limitless: just to *list* all of the opportunities that might come to mind would probably require more pages than the total number contained in this bulletin! The following few suggestions are therefore not intended as a list from which to choose, but rather as a brief list to stimulate *your* thinking about the opportunities which abound around your school, neighborhood, and community:

ANYWHERE LIVING PLANTS ARE GROWING—to observe examples of the *law of adaptation.*

AN ABANDONED LOT (FIELD)—to observe evidence of the *law of succession.* (The process might be more readily apparent on an area which has been abandoned within the previous five or ten years.)

IN THE SHADE OF A TREE—to investigate whether or not a tree might be a good "air conditioner" on a hot sunny day. What application does the finding have to the "energy problem?"

A PAVED PLAYGROUND OR PARKING LOT—to search for homes of animals. Didn't find any? Why not?

A STUMP OF A RECENTLY CUT TREE—to count growth rings and compute the tree's age when cut. How long would it take to grow another tree of the same size?

A HEAVILY USED PICNIC AREA—to look at the ground. Is the soil bare and exposed, or is it covered with plants? Why?

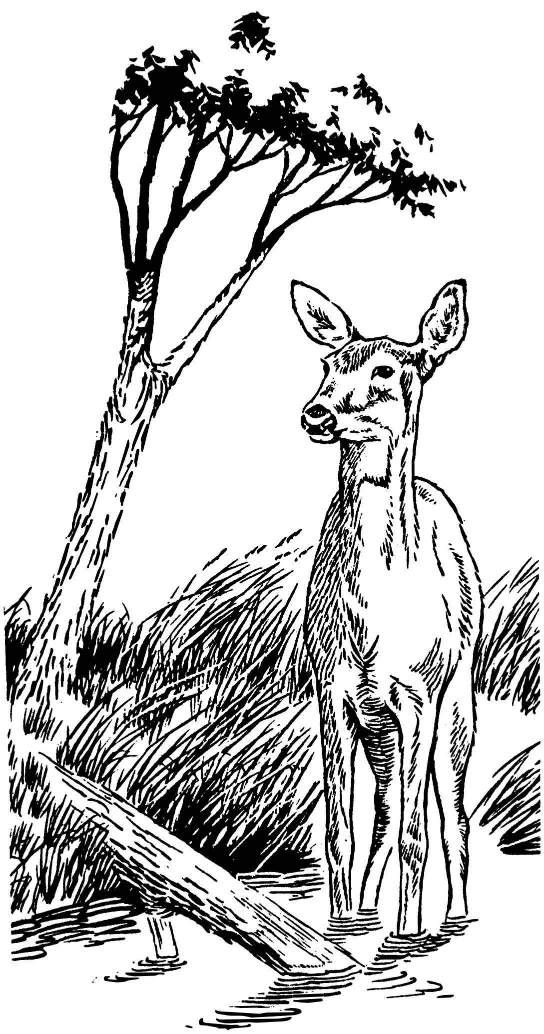
THE SCHOOL LUNCHROOM—to observe whether any food is being wasted. If so, how much? What kinds? What steps were involved in getting that food onto the lunch tray?

THE SCHOOL TRASH CONTAINER—to learn how

much "trash" is accumulated from your school in one day. Are there any items which could be used again? Are the papers being used on *both* sides?

THE COMMUNITY TRASH DISPOSAL SITE—to learn how much "waste" your community generates. Is there a better way of disposing of this material?

A NEW CONSTRUCTION SITE—to observe and discuss the effects. What was here before? Who? Where did they go? Who will benefit from this project? Who will be harmed (inconvenienced)? Who will pay the costs?



A BUS TOUR OF THE COMMUNITY AND SURROUNDING COUNTRYSIDE—to observe the ways in which man uses the land (space). Are there other ways in which man uses land in other areas? What determines how land is used? What *should* determine land use?

THE COMMUNITY WATER TREATMENT PLANT—to observe the process. Where do we get our water? What must be removed from the water to make it safe to use? Are there substances in the water that this treatment process cannot remove?

THE COMMUNITY SEWAGE TREATMENT FACILITY—to observe the process. Are there other processes? What is done with what is removed from the sewage? What else might be done with it?

AN AREA OF BARE SOIL DURING A RAIN (or immediately after if one cannot afford to get wet)—to observe the water that runs off. Is it clear or muddy? Why? Where is it going? What will it affect?

A DEPARTMENT OF CONSERVATION WILDLIFE AREA—to study nearly any aspect of ecology and the natural laws. For what purposes is the area used? By whom (don't forget yourself!)?

THE NEAREST RUNNING STREAM—to observe *everything!* Where does it come from? Where is it going? How fast? What lives in it? What cannot live in it? Why not? How is man using it? Is that good? Why?

A WOODS OR FOREST—to study a forest ecosystem (contrast it with a field ecosystem). Are the trees straight and tall, or are they shorter with spreading branches? Why? Are there many dead branches on the trees or on the ground? What covers the forest soil? What do you find in the forest floor cover?

A NEIGHBORHOOD SUPERMARKET—to note the great variety of items. Where did they come from? What was needed to produce them? How are they packaged? Could they be sold unpackaged or packaged another way?

A MODERN FARM—to observe the land use practices. What crops are being grown? Are they planted on the contour? Are there terraces, waterways, and other erosion control methods? How are weeds controlled? Are there other ways

available? How is soil fertility maintained? Is there a pond on the farm? What purposes does it serve? Is there cover for wildlife on the farm? What purposes does it serve? Does the farmer permit hunting on his land? Why or why not?

(It may be difficult to locate a farm to visit, especially near large urban centers. Call the University of Missouri Extension Office or the Soil Conservation Service office for assistance.)

A MANUFACTURING PLANT—to observe the entire process. What kind of raw materials (resources) does the industry use? Where do they come from? What does the plant use for its energy supply? Are there any problems of air or water pollution? How does the industry cope with them? Are other waste products a problem? How important is this industry to the economy of the community? What would happen if this industry were closed?

Any leader of a "show-and-tell" type field trip has a responsibility to know what features exist along the trip route, and which ones he or she plans to point out and explain. Unless the leader is quite familiar with the route and its features, and has been over it recently, the leader should make a preliminary trip before the scheduled field trip with the children. If certain features are *necessary* to the purpose of the field trip, the leader must make sure that those features are there (some experienced field trip leaders go so far as to suggest that, if necessary, one even go out the night before and put the needed feature there!)

A teacher who wishes to conduct an investigative type field trip should become acquainted with the special techniques involved; this may require the teacher's participation in a special short course or workshop. Once familiar with the methods and techniques for this type of field trip, then the teacher must prepare as for any other type of lesson—make certain that all needed equipment and supplies are on hand and ready to use, have introductory material well in mind, have discussion questions formulated, and be prepared for unexpected findings by the pupils. Since it is difficult to gauge the actual time pupils will spend on any given investigation, it is also well to prepare for several more investigations than one anticipates using. Such preparations will not be wasted; they can always be used for the next trip.

(NOTE: The Conservation Education Unit of the Department of Conservation will arrange a workshop to acquaint teachers and other youth leaders with some of the techniques of investigative type field experiences. Write to the Conservation Education Unit, Missouri Department of Conservation, P.O. Box 180, Jefferson City, Missouri 65102, for further information.)

As stated before, field trips are probably the best method for providing children with opportunities for a wide variety of experiences within and about man's environment. But few, if any, children will actually be provided an adequate number of field ex-

periences so as to become as well informed as will be necessary if they are to develop those attitudes and subsequently behaviors that can properly be labeled "conservation." Therefore every teacher and youth leader will still need to rely heavily on all of those good teaching methods and techniques which have served well and proved effective in the past.

But what does one teach with all of these tried and true methods? Facts! Accurate, factual information about man's environment, its resources, and his use (and abuse) of them.

This is not quite so easy as it may first seem. It is increasingly difficult to determine just what are the "facts." Each potential user of a resource supports his claim that such use is conservation with "facts." When several competing users each support their claims with such "facts," separating fact from propaganda becomes difficult.

Traditionally science has provided real facts—as best they could be determined. It still does. But as science and technology have become ever more interwoven, and as many scientists now conduct research primarily to support and improve the technology of their employer, it has become increasingly confusing to judge what is truly unbiased scientific fact. The teacher, the youth leader, the average lay person (as well as the "professional" conservationist) becomes bewildered when reputable scientists disagree publicly over the "facts" related to the use of a resource.

Examples abound—the safety of nuclear power production; acceptable levels of particular pollutants in air or water; use of chemicals in agriculture; effects of supersonic aircraft; the need for development of alternative energy sources; the status of certain wildlife species. There are countless others, and when economic and political considerations are interjected into the discussions the "facts" do indeed become even more obscure! But we must try.

Present accurate and factual information about man's environment, its resources, and man's use of them.

The third task then for any teacher, youth leader, or parent who is concerned about conservation education for their children is to present to the best of one's ability the most accurate and factual information available about man's environment, its resources, and man's use of them. Whenever it is impossible for one to determine which are the true facts, then one must present all of the information possible so that the pupils may evaluate for themselves. (This may at times require the presentation of contradictory information.)

Conservation education must be infused into all subjects and it must include man as a factor.

Two important points must be stressed about environmental conservation education: 1) it must be infused into all subject matter areas at all grade levels, and 2) it must always include "man" as one factor in consideration of interrelationships.

Although this bulletin has been titled *An Ecological Approach* ... and most of the content has been devoted to presenting ecological understandings, it should not be inferred that the teaching of environmental conservation belongs only to the realm of science. Previous statements have stressed that conservation behaviors are dependent upon conservation *attitudes*—and one certainly does not

develop an attitude through educational efforts which are restricted to only one subject area! If conservation attitudes can be developed through education in the classroom, then *all* teachers must accept a part of the responsibility.

This does not mean that the mathematics teacher can expect to include as much conservation teaching in his or her classroom as does the biology teacher during an ecology unit, or that the music teacher will present environmental conservation facts to the degree that the teacher of a "Contemporary Issues" course might, but it does mean that each and every teacher does have a responsibility—and probably a lot more opportunities than one at first might realize—to the pupils, to our society, and to man as a species.

Subject Areas

Previously in this section a brief list of suggestions for field trips was presented to stimulate your thinking about opportunities for conducting this type of activity. Likewise the following list of suggestions for infusing environmental conservation education into various subject areas should not be considered as a list from which to choose, but rather should be used to stimulate *your* thinking about opportunities which exist in your particular subject area and grade level:

BIOLOGY—Expand upon the organization and topics presented in the first section of this bulletin; i.e., emphasize ecological concepts and understandings, especially those involving man as a factor.

CHEMISTRY—Test soil samples for organic matter and plant nutrients; compare a sample from topsoil to one from subsoil, from virgin soil to field or garden soil, from a floodplain to a ridgetop.

Test water samples from various sources (including tap water). Are there any pollutants? What kind? Where might they have come from? How can they be removed?

Discuss the chemical changes which occur in various biogeochemical cycles in nature. What effects does man's introduction of fertilizers, insecticides, and herbicides have upon such cycles?

PHYSICS—Consider man's utilization of various types of energy sources. Which are most efficient? Which sources cause the least pollution? What are most abundant? Are any of them greater hazards to ecosystems than others?

Investigate the relationship between soil-carrying capacity and water flowing velocities.

Investigate the effects of various levels of sound upon various organisms (especially man).

EARTH SCIENCE—Emphasize that *man* has become a major agent for changing the face of the Earth. How does man induce erosion and aggradation? In what ways does he change topography? What are the effects of his extraction of minerals and fossil fuels? How does man modify weather and the atmosphere?

What physical factors affect man's use of the land?

SOCIAL SCIENCES—*Geography* is the science which considers the relationship of man to his environment: therefore, emphasize the question of whether or not his relationships have been "wise?"

Determine the *real* causes of most wars. Were they for control of resources (although another reason may have been stated)?

Consider the relationship which exists between a nation's supply of resources and the wealth and power of that nation.

Study the history of the rise and fall of ancient civilizations in relation to the development and exhaustion of their resources.

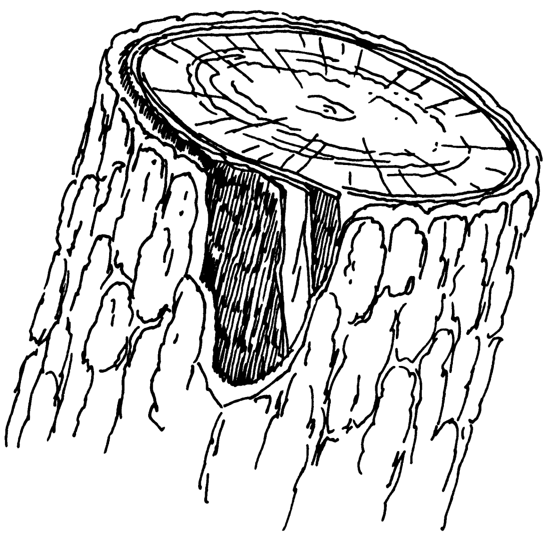
Discuss current newspaper clippings and magazine articles which are related to man's use of his environment.

Study the history of your community. Why was it settled? What changes in land use have occured? Has there been significant shifts in the distribution or composition of the population?

Discuss factors which cause population migrations. Was the westward movement across the United States a search for resources?

Which (federal; state; local) governmental units (departments; bureaus; agencies) are legally responsible for administering the laws and regulations which relate to citizens' use of resources? How effective and efficient are their programs? What should be government's role in the conservation of resources?

Trace the history of wildlife populations in Missouri through the stages of abundance, decline, restoration, and current status and outlook.



Obtain a cross section from a large tree for which the year of cutting is known. By counting growth rings locate and place labeled markers on those rings which correspond to the years of interesting historical events.

LANGUAGE ARTS—Suggest that pupils write themes, essays, and research papers on topics related to man's use of his environment.

Suggest that pupils write editorials regarding local examples of good (bad) conservation; submit well-written ones to the local newspaper.

Suggest that pupils write short stories or poems (various kinds) which express how they *feel* about specific environmental conditions.

Use conservation topics for practicing various types of oral communication.

Discuss the many works of literature which were inspired by the land and its resources. Would the author or poet be so inspired today?

Read biographies of persons who are recognized as outstanding leaders in the conservation movement; follow-up by reading some of their writings.

In foreign language classes write letters (in the language being studied) to agencies of nations which use the language and re-

quest publications which are related to conservation in that nation.

ART—Sketch, paint and draw cartoons of good and bad examples of resource use in the community.

Use "natural" materials from the environment to create various art forms; emphasize to pupils that everything they use comes from the resources.

Use materials which are usually wasted to create art forms; discuss other opportunities for man to reduce waste by re-use procedures.

Observe colors, shades, design, texture, and forms which occur in the "natural" environment.

MUSIC—As in literature, discuss the works of composers who were inspired by the land and its resources; listen to such compositions during appreciation sessions

Learn to play and sing some of the more recent songs which refer to man's use (abuse) of his environment.

Use the *Missouri Conservation Melodies* songbook in your classes. This 254 page publication is designed for kindergarten through adult users and includes various solo and group, vocal and instrumental selections. A sing-along cassette tape is also available featuring ten of the selections. The book and tape are available from the Department of Conservation.

MATHEMATICS—Write or re-write verbal problems so that they relate to conservation topics.

Use graphs and charts which depict data related to man and his use of his environment — population growth; population distribution; food production; energy consumption; rate of use of various mineral resources; timber production; timber harvest; water use; costs of "conservation" projects; wildlife populations; economic values of various outdoor recreational activities; etc.....

HOME ECONOMICS—Discuss the effects of soil depletion (loss of plant nutrients) and soil erosion upon nutritional values of food.

Investigate the effects of air and water pollution on family health.

Learn to prepare and serve game and fish dishes; discuss the economic value of foodstuffs which come from the wild.

Study the factors which determine human population growth or decline. What effects might result if each family decided to produce only two children? What if each family opted for three instead of two? Four? Discuss these questions from the viewpoint of the individual family; the community; the nation; the world.

INDUSTRIAL ARTS—Study the relationship between the availability and cost of high quality hardwood lumber to

the hardwood forest resource.

Determine the factors involved in the cost of metals used in shop projects.

Stress the elimination of waste of materials in all shop projects; use "scraps" whenever possible.

Involve your students in woodworking projects beneficial to wildlife by requesting a copy of *Woodworking for Wildlife* from the Missouri Department of Conservation.

PHYSICAL EDUCATION—Emphasize hunter education, casting, campcrafts, and related outdoor recreational skills, especially in "lifetime sports" programs. Include discussions of topics such as: why hunting and fishing rules and regulations?; the ethics of using land for recreation; reasons for conflicts between private landowners and the recreation-seeking public; rights and responsibilities on public lands; the values of "natural" and wilderness areas; the pro and con of hunting, fishing, and trapping activities.

DRIVER EDUCATION—Point out to *passengers* the various uses and abuses of man's environment (especially note the litter alongside the roadway).

Summary

A couple of final thoughts about teaching conservation. Much has been said and written about achieving a "quality life" for everyone as being the ultimate goal for environmental conservation.

What is a quality life?

What is a "quality life?" Is it the same for all persons in all societies?

Since everyone is most concerned about himself or herself, it might be beneficial to have pupils work out the answers to a series of three questions:

1) What criteria do you perceive as being necessary for *you* to achieve *your* goal of a "quality life?"
2) What is necessary — in terms of resources and the environment for you to realize this goal?
3) How can you achieve this goal without having an adverse effect upon man's environment?

It might also be beneficial for every teacher, youth leader, parent (and "professional conservationist") to work out the answers to the very same questions!

One of the most frequent questions asked by pupils (and many adults) is "What can *I* do about conservation?" The best reply lies (again) in the answer to two questions:

1) What am *I* doing that is harmful to man's environment?
2) What can I do instead? (What are the alternatives? Is there a less harmful way of accomplishing my same purpose?)

Do it!

Teaching about man's environment, its resources, and his use (and abuse) of them — especially when one is trying to instill attitudes which will result in conservation behaviors — can be one of the most rewarding (and most frustrating) of all educational endeavors; it is certainly one of the most necessary.

Bon voyage!

Lesson Plan No. 1

TITLE: Ecological Conservation: An Overview

MATERIALS: Film: "Our Wild Inheritance" (MDC), Conservation Ethics Word Scramble

OBJECTIVES: After completing this lesson the student should be able to:

1. Define conservation five different ways.
2. Identify and explain three levels of conservation effort and include examples of each.
3. Recognize the need to deal with problem situations in the environment before they become crises.
4. Identify and discuss five reasons why conservation is directly related to our well-being and quality of living.

METHOD: Film, lecture, discussion

PROCEDURE:

I. Introduction
   - A. Conservation is of utmost importance to youth

II. Presentation
   - A. Definitions of conservation
     1. The use of the natural resources for the greatest good of the greatest number for the longest time
     2. The wise use of natural resources
     3. Conservation consists in the recognition by man of his interdependence with his environment and with life everywhere and the development of a culture which maintains that relationship through policies and practices necessary to secure the future of an environment fit for life and fit for living
     4. A state of harmony between man and land
     5. A philosophy of daily living
   - B. Levels of conservation effort
     1. Preservation
        - a. means saving
        - b. prohibiting harvest of limited or endangered species, e.g., the prairie chicken
     2. Restoration
        - a. means restocking, replanting, and renewing existing resources
        - b. white-tailed deer flourished all over Missouri after the restoration program
     3. Management
        - a. level where decisions are made and improvement plans are implemented
        - b. conservation requires maintenance—soil fertility and erosion control don't just happen, they are planned
   - C. Crises in the environment
     1. Tendency to react only when forced by nature
        - a. energy
        - b. air pollution
        - c. decreasing wildlife numbers
     2. Examples of neglect and misuse of natural resources
     3. Scope of conservation
        - a. natural physical resources
        - b. man-made physical resources

D. Reasons for conservation
   1. Economic
      a. necessities and luxuries come from the land
      b. some natural resources are renewable—some are not. We must safeguard what we have.
   2. Political
      a. our society is fortunate to have a strong resource foundation
      b. we can choose how we want to use our resources (some countries cannot)
      c. only if we allow for renewal and proper use will we continue to enjoy this choice
   3. Aesthetic
      a. the urge to "get away from it all" on occasion arises in us all
      b. scientific evidence indicates we must have this association with nature to exist
   4. Scientific
      a. nature is the only unaltered standard by which man can compare his surroundings
   5. Moral
      a. we have no right to destroy the surroundings upon which we depend.
      b. we are obligated to safeguard our environment

E. Film: "Our Wild Inheritance"

F. Word Scramble: Conservation Ethics

III. Summary

A. Overview of conservation and its relationship to us

B. We are consumers yet perpetuators and guardians of our environment

Lesson Plan No. 2

TITLE: Basic Ecological Understandings

MATERIALS: Crossword Puzzle: Ecology, Transparency of Biotic Pyramid

OBJECTIVES: Upon completion of this lesson the student should be able to:

1. Define ecology.
2. Identify the levels of biological organization.
3. Identify the factors which determine the kinds of organisms that exist within an ecosystem.
4. Explain the law of adaptation and law of succession.
5. Define "sere" and discuss its relationship to a climax community.
6. Define and give an example of a food chain.
7. Identify the components of the pyramid of life.
8. Discuss the laws of control and multiplication.
9. Define carrying capacity.

METHOD: Lecture, discussion

PROCEDURE: I. Introduction

A. The word ecology is derived from the Greek words "Okios" which means house and "Logos" which means discussion or study. Nature is therefore like a house. The house we and all other living organisms call home.

II. Presentation

A. Definition of ecology

1. A division of biology dealing with the interrelationships among organisms and their environment.

B. Concept of biological organization
   1. Levels of organization
      a. protoplasm
      b. cells
      c. tissues
      d. organs
      e. organ systems
      f. organisms
      g. populations
      h. communities
      i. ecosystems
      j. biosphere
   2. Ecological divisions
      a. beyond individual organism
      b. latter four levels

C. Factors which determine kinds of organisms in an ecosystem
   1. Conditions within the non-living portion of the ecosystem
   2. Interactions among the community members within the ecosystem

D. Law of adaptation
   1. A community is comprised of those organisms best adapted to a particular environment.

E. Law of succession
   1. Organisms modify their environment
   2. New organisms "succeed" or replace old ones
   3. This predictable series of temporary communities are called seres
   4. A climax community develops
      a. able to survive its own modifications of its environment
      b. stable yet dynamic

F. Transfers of food energy
   1. The food chain
   2. Pyramid of life
      a. energy flow
      b. raw materials cycle

G. Law of multiplication
   1. Power of reproduction
   2. More young are produced than can survive in the environment

H. The law of control
   1. Prevents any species from overrunning the earth
      a. natural disasters
      b. fires
      c. starvation
      d. predation
      e. others
   2. Balances population and habitat

I. Carrying capacity
   1. The maximum number of species or organisms which can be supported by an ecosystem
   2. Maximum productivity

III. Summary

A. Basic ecological laws, definitions, and practices

B. Man is subject to laws of nature

C. Crossword puzzle: Ecology

Lesson Plan No. 3

TITLE: Man's Ecological Relationships

OBJECTIVES: After completing this lesson the student should be able to:

1. Distinguish between man's adaptations to his environment and the artificial environments he has created for himself.
2. Describe the relationship between diversity and the stability of an ecosystem.
3. Identify the factors that may restrict human population growth.

METHOD: Lecture, discussion

PROCEDURE:

I. Introduction
   - A. What is our place in the environment?
   - B. Humans cannot be excluded from nature's laws

II. Presentation
   - A. Adapting to the environment
     1. Adaptations
        - a. mountain tribes and low oxygen
        - b. tropical sun and skin pigmentation
     2. Artificial environments
        - a. garments able to withstand extreme heat or cold
        - b. underwater breathing apparatus
        - c. spacesuits
     3. Alters surroundings to fulfill survival needs
   - B. Manipulating the environment
     1. Use of fertilizers
     2. Irrigation
     3. Wetland drainage
     4. Introduced species
        - a. agricultural crops—none are native to U.S.
        - b. undesirable exotics—German carp, house sparrow, starling, Johnson grass, hemp, musk thistle, gypsy moth, Norway rat, house mouse
     5. Management of seral stages
        - a. wildlife and forest production
        - b. food crops
   - C. Diversity and stability
     1. Diversification increases survival potential of species attacked by pests or disease or when environmental conditions change
     2. Monoculture—risks total loss if environmental conditions change
   - D. Human population growth
     1. Growth formula
     2. Carrying capacity of the earth

III. Summary
   - A. We are part of nature and subject to its laws
   - B. Humans have never upstaged nature and never will
   - C. We must exist in harmony with nature to survive

Glossary

biosphere: that portion of the earth which can and does support life—the soil, air and water.

calorie: amount of heat needed to raise the temperature of one gram of water one degree centigrade.

Calorie: 1000 calories (kilocalorie)

carnivores: animals which eat other animals.

carrying capacity: maximum population that a given ecosystem can support indefinitely.

climax community: a community capable of propogating itself in a relatively stable, yet dynamic condition.

community: all the populations in a given area.

conservation: the wise use of natural resources. (The criteria for "wise use" can be the original concept of conservation by Pinchot: "greatest good for the greatest number in the long run.") "a state of harmony between man and the land"...Aldo Leopold.

conservation education: all the activities and experiences which result in learning about man's dependency upon and use of natural resources for his needs and wants.

decomposers: (transformers) organisms which obtain their energy from that remaining stored within the tissues of dead organisms, thus extracting the final bits of energy from the food chain and forming a residue of raw non-energy materials.

ecological succession: (law of succession) the natural replacement of one plant community by another; the progressive development of vegetation towards its highest ecological expression, the climax.

ecology: the study of interrelationships of organisms to one another and to their environment.

ecosystem: a community (living organisms) and its non-living environment.

environment: the sum total of all the external conditions that may act upon an organism or community to influence its development or existence.

exotic species: species of plants and animals which are imported to an ecosystem of which they were not previously a part.

food chain: series of transfers of food energy from one organism to another.

herbivores: animals which eat plants.

law of adaptation: the community is comprised of those organisms best adapted to that environment.

law of control: means of preventing unlimited growth in numbers of organisms (i.e., predation, disease, parasitism, starvation, floods, fires, etc.)

law of multiplication: organisms have the potential to produce progency many times the numbers of the parent stock.

limiting factors: those factors which limit population increase due to their presence in too high or too low a concentration.

management: making decisions and implementing practices which maintain a resource so it can continue to be used.

omnivores: animals which eat both plants and other animals.

organism: any living thing.

population: groups of individuals of any one kind of organism that occupy a given area.

population growth: the net result of the interaction of the laws of multiplication and control. Population growth can be either positive (increasing) or negative (decreasing).

preservation: saving a resource by not using it.

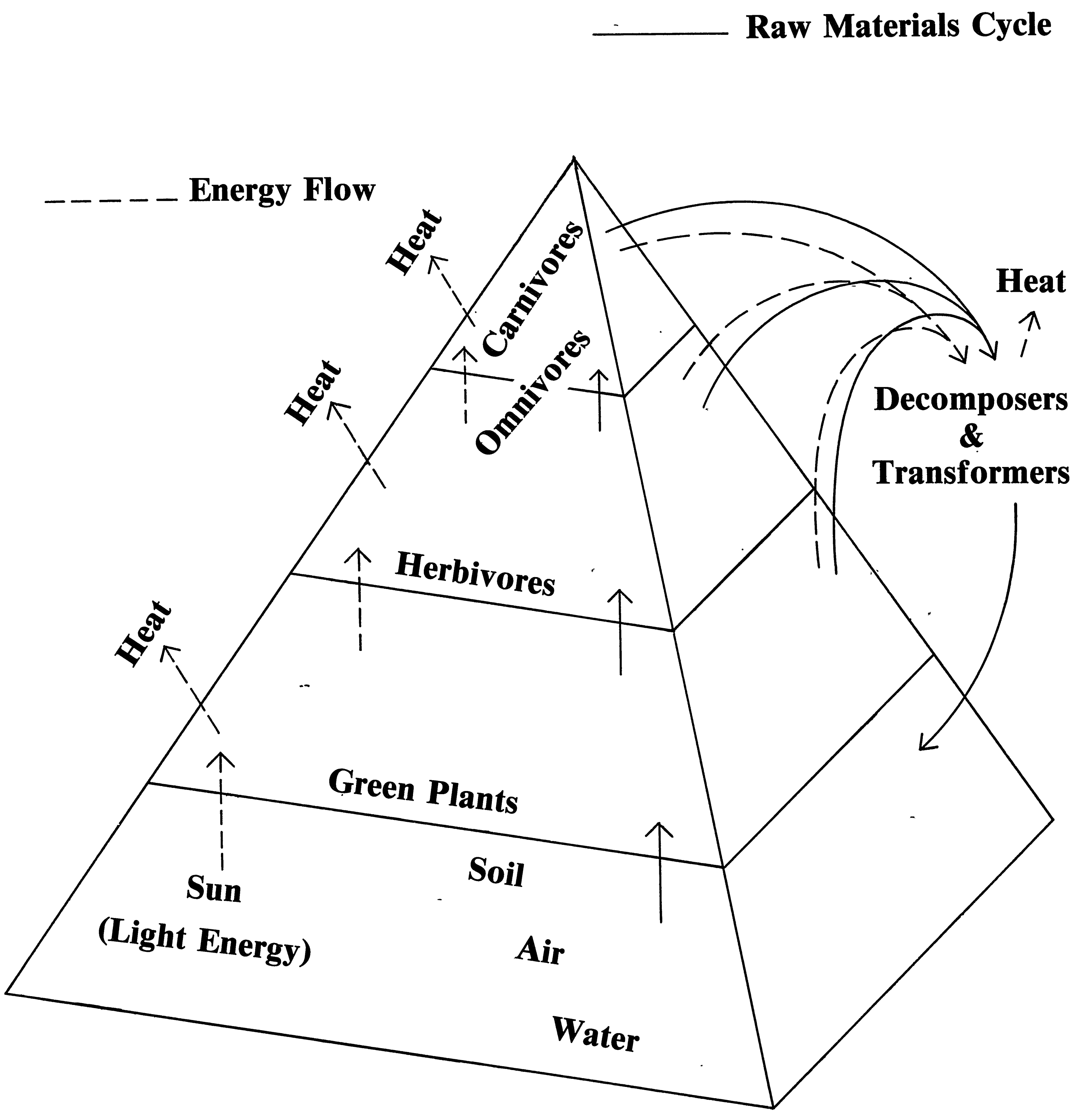
pyramid of life (biotic pyramid): illustration which depicts the process of energy and materials flow through a food chain and the decrease of available energy due to the conversion of energy to heat which is lost from the system.

restoration: long term effort to reestablish the original quality of the unit being restored.

seral stage: a temporary community.

sere: the series of communities which result in a climax community.

Pyramid of Life



Conservation Ethics

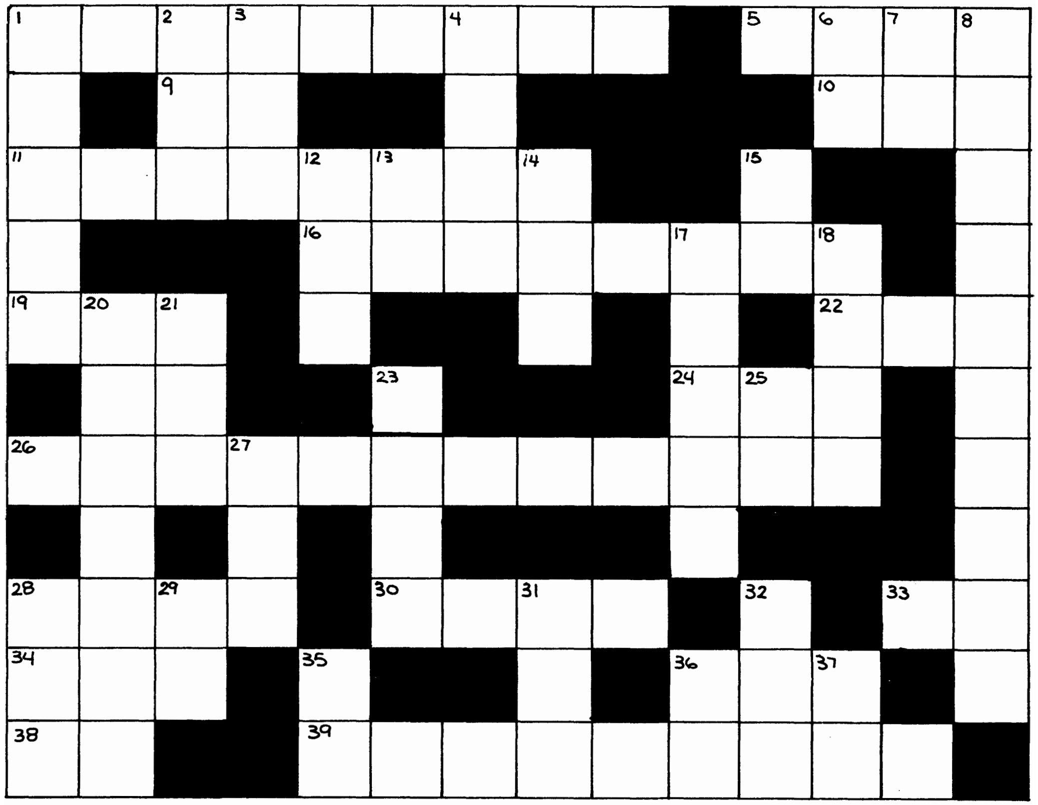
word scramble

C	O	L	P	R	O	T	E	C	T	R	A	T
O	X	A	O	A	N	R	C	S	I	O	P	C
N	Y	W	L	T	A	S	I	E	N	T	Y	A
S	L	A	L	E	R	Y	H	O	A	R	U	V
E	Q	S	U	B	S	E	T	C	T	A	W	D
R	E	T	T	I	L	L	E	N	U	X	W	L
V	K	E	I	K	O	N	U	G	R	I	A	F
E	O	N	O	T	K	O	H	I	E	K	L	R
J	M	U	N	Y	C	I	N	O	E	L	Y	E
I	S	M	A	O	O	S	E	N	I	L	I	C
W	A	T	E	R	S	E	P	K	O	R	Q	Y
A	E	V	O	B	U	T	H	Y	C	W	U	C
I	V	R	S	X	W	S	Y	P	L	E	H	L
Z	A	P	I	N	I	X	U	O	G	R	E	E
A	S	K	D	F	O	C	F	T	R	A	S	H

Find the words below in the puzzle and circle them. The words can go either up, down, across or diagonally.

RECYCLE	SMOKE
WATER	WASTE
POLLUTION	TRASH
LITTER	NOISE
SAVE	COUNTRY
FISH KILL	LAW
CONSERVE	LAKE
FIRE	ETHIC
HELP	NATURE
PROTECT	TOXIC

Ecology Puzzle



DOWN

1. rot
2. is able
3. opposite of offs
4. margarine
6. on or near
7. Missouri (abbr.)
8. the number of organisms in a region
12. opposie of downs
13. mister (abbr.)
14. roads (abbr.)
15. exist
17. food ____, sequence of feeding organisms
18. precipitation
20. the study of organisms and their environment
21. male child
23. a snare used for taking game
25. ____ and behold
27. source of energy
28. a barrier to stop the flow of water
29. us
31. dwarf
32. distress signal
35. ____ ____ Simpson
36. Junior (abbr.)
37. opposite of stop

ACROSS

1. to break down into basic parts
5. sleep in a tent
9. form of a, ______apple
10. also
11. organism which eats other species
16. traps solar energy (green plant)
19. opposite of no
22. every
24. Muhammad _____
26. wise use of natural resources
28. opposite of up
30. eaten by a predator
33. opposite of yes
34. number of years lived
36. run
38. belonging to me
39. capital of Missouri, _____ City

NAME ______________________________

An Ecological Approach To Conservation Education

Suggested Exam Questions

Completion

1. Define Conservation - (One of the five different ways studied in text)

2. List and give an example of each of the three levels of conservation effort.

   A.

   B.

   C.

3. Name five reasons conservation is related to our well being and quality of life?

   A.

   B.

   C.

   D.

   E.

4. List the levels of biological organization and indicate which are the primary concern of ecology.

5. Name and define the four basic laws of nature.

6. Describe the relationship between diversity and the stability of an ecosystem.

7. Name three factors which restrict human population growth.

Matching (From Glossary)

______ 1. biosphere	A. A community (living organisms) and its non-living environment
______ 2. carnivores	B. Animals which eat plants
	C. Animals which eat plants and animals
______ 3. carrying capacity	D. Animals which eat other animals
	E. A temporary community
______ 4. conservation	F. The series of communities which result in a climax community
______ 5. ecology	G. Study of interrelationships of organisms to one another and to their environment.
______ 6. ecosystem	H. That which limits population increase with presence of high or low concentrations.
______ 7. herbivores	I. Part of the earth which supports life—soil, air, and water.
	J. Saving a resource by not using it
______ 8. law of control	K. A long term effort to establish original quality of unit being restored.
______ 9. omnivores	L. Maximum population which can be supported by ecosystem.
	M. Means of preventing unlimited growth in numbers of organisms
______10. preservation	N. The wise use of natural resources
______11. seral stage	
______12. limiting factors	

An Ecological Approach To Conservation Education

Exam Answers

Completion

1. A. Use of natural resources for the greatest good of the greatest number for the longest time.
   B. Wise use of natural resources.
   C. Conservation consists in the recognition by man of his interdependence with his environment and with life everywhere and the development of a culture which maintains that relationship through policies and practices necessary to secure the future of an environment fit for life and fit for living.
   D. A state of harmony between man and land.
   E. A philosophy of daily living.

2. Preservation - hunting limitations on wild species
   Restoration - restocking and replanting populations such as white-tailed deer and otters
   Management - maintenance of soil fertility and erosion control

3. Economic, political, aesthetic, scientific, moral

4. Biology can be organized in a spectrum ranging from smallest to largest: protoplasm, cells, tissues, organs, organ systems, organisms, populations, communities, ecosystem, and the biosphere. Ecology concerns the last 4 levels.

5. Law of adaptation: community is comprised of organisms best adapted to that environment.
   Succession: natural replacement of one plant community by another; progressive development of vegetation towards the ecological vegetative climax
   Multiplication: organisms have the potential to produce progeny many times the number of the parent stock. More young are produced than can survive the environment.
   Control: conditions which prevent unlimited growth in numbers of organisms (predation, disease, limiting factors)

6. A variety of species can survive different degrees of effects of weather conditions, insect infestation, and disease whereas dependency on one species could be disasterous if insects or disease harmful only to that species attacked it.

7. Death, birth control and carrying capacity.

Matching

1. I	7. B
2. D	8. M
3. L	9. C
4. N	10. J
5. G	11. E
6. A	12. H

Puzzle Key

1 d	e	2 c	3 o	m	p	4 o	s	e	■	5 c	6 a	7 m	8 p
e	■	9 a	n	■	■	l	■	■	■	■	10 t	o	o
11 c	o	n	s	12 u	13 m	e	14 r	■	■	15 b	■	■	p
a	■	■	■	16 p	r	o	d	u	17 c	e	18 r	■	u
19 y	20 e	21 s	■	s	■	■	s	■	h	■	22 a	l	l
■	c	o	■	■	23 t	■	■	■	24 a	25 l	i	■	a
26 c	o	n	27 s	e	r	v	a	t	i	o	n	■	t
■	l	■	u	■	a	■	■	■	n	■	■	■	i
28 d	o	29 w	n	■	30 p	r	31 e	y	■	32 s	■	33 n	o
34 a	g	e	■	35 o	■	■	l	■	36 j	o	37 g	■	n
38 m	y	■	■	39 j	e	f	f	e	r	s	o	n	■

C	O	L	P	R	O	T	E	C	T	R	A	T
O	X	A	O	A	N	R	C	S	I	O	P	C
N	Y	W	L	T	A	S	I	E	N	T	Y	A
S	L	A	L	E	R	Y	H	O	A	R	U	V
E	Q	S	U	B	S	E	T	C	T	A	W	D
R	E	T	T	I	L	L	E	N	U	X	W	L
V	K	E	I	K	O	N	U	G	R	I	A	F
E	O	N	O	T	K	O	H	I	E	K	L	R
J	M	U	N	Y	C	I	N	O	E	L	Y	E
I	S	M	A	O	O	S	E	N	I	L	I	C
W	A	T	E	R	S	E	P	K	O	R	Q	Y
A	E	V	O	B	U	T	H	Y	C	W	U	C
I	V	R	S	X	W	S	Y	P	L	E	H	L
Z	A	P	I	N	I	X	U	O	G	R	E	E
A	S	K	D	F	O	C	F	T	R	A	S	H

Core Competencies and Key Skills Addressed in *An Ecological Approach to Conservation Education*

LEVEL VII

Language Arts/Reading/English

Reading: A-4, B-1, C-4, C-5, C-7, C-8, C-10, D-1, D-2, D-3, D-6
Writing: F-2, G-2, G-3, G-4, G-5, G-7, G-12, G-13
Listening/Speaking: H-1, H-2, H-3, H-4, I-1, I-2, I-3, I-4, J-1, J-3, J-4, K-1, K-2, K-3, K-4

Mathematics

Mathematics: G-1, G-2, G-5, H-1, H-2, H-3

Science

Science: A-6, B-1, B-2, B-3, C-4, D-7, D-11, D-12, D-13, D-14, E-3, E-5

Social Studies/Civics

Geography: B-1, B-3, C-1
History: E-1, H-5, F-1
Government (Civics): G-1, I-1, I-3, K-1, L-1, L-2
Economics: M-1, N-1, P-1, Q-1
Other Social Studies Competencies: V-1, V-2, V-3, V-4

LEVEL VIII

Language Arts/Reading/English

Reading: B-1, C-3, C-4, C-6, C-7, C-9, C-10, D-1, D-2, D-3, D-7
Writing: F-2, G-2, G-4, G-5, G-6, G-10, G-11, G-12
Listening/Speaking: H-1, H-2, H-3, H-4, I-1, I-2, I-3, I-4, J-1, J-3, J-4, K-1, K-2, K-3, K-4

Mathematics

Mathematics: F-1, G-1, G-2, H-4, H-5

Science

Science: B-15, D-4, E-1, E-2, F-5, G-1, H-1, J-3

Social Studies/Civics

Geography: A-4, B-1
History: E-1, E-2, E-3, E-4, F-1
Government (Civics): G-3, H-3, I-2, J-2, K-1, L-1, L-2, L-3
Economics: M-1, N-1, N-2, P-1, Q-1
Other Social Studies Competencies: V-1, V-2, V-3, V-4

LEVEL IX

Language Arts/Reading/English

Reading: B-1, B-5, C-6, C-8, C-9, C-10, C-11, C-12, D-1, D-2, D-3, D-4, D-5, D-6, D-8
Writing: F-3, G-1, G-2, G-3, G-4, G-5, G-6, G-9, G-10, G-11
Listening/Speaking: H-1, H-3, H-4, H-5, H-6, H-7, I-2, J-2, J-4, J-5, K-1, K-2, K-3, K-4, K-5

Science

Science: A-1, D-1, D-2, D-5, D-9, E-1, F-2, H-1, J-1

Social Studies/Civics

Geography: B-1
History: E-2, E-3, F-1
Government (Civics): I-3, I-4, K-1, L-1, L-2
Economics: M-1, M-2, N-1, O-3, P-2
Other Social Studies Competencies: S-2, S-3, V-1, V-2, V-3, V-4

LEVEL X

Language Arts/Reading/English

Reading: B-1, B-4, C-2, C-4, C-6, C-13, C-14, D-1, D-2, D-3, D-4, D-5, D-6, D-8
Writing: F-3, G-1, G-2, G-3, G-4, G-5, G-8, G-9, G-10
Listening/Speaking: H-1, H-3, H-4, H-5, H-6, H-7, I-2, J-2, J-4, J-5, K-1, K-2, K-3, K-4, K-5

Mathematics

Mathematics: F-3, G-1, G-2, G-3

Science

Science: A-2, A-3, A-6, D-4, D-12, E-4, F-4, F-5, H-1, H-2, J-1, J-2, J-4

Social Studies/Civics

Geography: B-1, B-2, B-3, C-1
History: E-2, E-3, E-4, E-5, E-6, F-1, F-2
Government (Civics): J-3, K-1, L-1, L-2, L-3, L-4
Economics: M-1, M-2, M-3, N-1, P-2, P-5, P-6, Q-3
Other Social Studies Competencies: S-2, S-3, V-1, V-2